DOCUMENT RESUME

ED 095 307 95 CE 001 859

AUTHOR	Small, Hazel Christine
TITLE	Effectiveness of Reinforcement Schedule in Relation to Certain Adult Characteristics Using Computer Assisted Instruction. Adult Learning Resources Project, Research Monograph No. 3.
INSTITUTION	North Carolina State Univ., Raleigh. Dept. of Adult Education.
SPONS AGENCY	Bureau of Adult, Vocational, and Technical Education (DHEW/OE), Washington, D.C.
PUB DATE	Jun 70
GRANT	OEG-2-7-003903-3903
NOTE	196p.
EDRS PRICE	MF-$0.75 HC-$9.00 PLUS POSTAGE
DESCRIPTORS	Adult Basic Education; Adult Characteristics; *Adult Learning; Autoinstructional Methods; *Computer Assisted Instruction; Computer Oriented Programs; Data Analysis; Evaluation Methods; Man Machine Systems; Motivation; *Reinforcement; Self Actualization; *Self Concept; Self Concept Tests; Tables (Data)
IDENTIFIERS	Adult Education Act 1966

ABSTRACT

The monograph reports the problem, design, and findings of graduate student research directly related to adult basic education teacher training. The objectives of this experiment were to assess: (1) the degree of relationship among reinforcement, learning, and self-concept for adults using computer assisted instruction (CAI); (2) changes in learner performance with changes in reinforcement schedule; and (3) the contribution of self-concept to changes in learner performance when reinforcement schedule is varied. It was concluded that the sample of adults exhibited self-concepts which were significantly lower than had been predicted. Data indicated significant differences between correlations of self-concept, treatments, and all four learner performances: (1) achievement, (2) trials, (3) time, and (4) errors. An examination of overall CAI performance indicated that those learners with the least enabling ability required more trials but made more actual gains without regard to self-concept scores on treatment effects. Having investigated a number of variables aiding in the design of CAI materials and programs, problems for further research are suggested. A 30-page bibliography and appendix concludes the document. (Author/MW)

NCSU ADULT LEARNING RESOURCES PROJECT

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This is a demonstration project funded by the Adult Education Branch of the U.S. Office of Education. It is an integral part of the research and development program of the Department of Adult Education at North Carolina State University.

PURPOSE

Purpose of the project is identification, development, demonstration and evaluation of innovative curriculum materials and instructional methods that will accelerate and enhance learning for undereducated adults. Special emphasis is placed on the use of educational media.

CURRICULUM

Currently available self-directed and programmed instructional materials in reading, computation, home and family life, consumer education and citizenship are being used. New instructional materials in these and other fields are being developed, adapted for programmed and computer assisted instruction and used in research designs which test their effectiveness with adult learners.

SPECIAL MEDIA

Educational media in use include an IBM 1500 Computer Assisted Instructional System. Computer assisted instruction (CAI) programs are designed for individualized instructional purposes and demonstrate the unique role of the computer in the teaching-learning situation.

Capabilities of CAI systems permit unlimited variation in teaching techniques. Drill and practice; tutor and test; games and simulation are only four of numerous CAI learning elements. An exciting new element is learner-controlled instruction, which allows the student to choose and pursue the path of learning he finds most challenging.

Additional teaching media expand the project's capacity to offer and evaluate individualized instructional strategies. These media include the electronic remote blackboard; the Language Master; pro-

STUDENTS

Students who come to the center are volunteer learners. Any adult, age 18 or over, who wishes to improve his basic educational and social skills, is eligible to enroll. Study schedules are conveniently arranged from 8 a.m. to 10 p.m. Each student is enrolled in a program designed to meet his personal needs and goals.

OUTREACH

Another dimension of the project is dissemination of information. "Outreach" efforts include communication of activities and results to other institutions, agencies and individuals involved in local, state, regional and national adult basic education programs.

Training is an important component. In-service seminars, institutes and workshops for adult basic education teachers, teacher-trainers and administrators are conducted for local, state and regional groups.

Additional training is provided through electronic sending and receiving units installed at four community colleges. One instructor at the center's master control system can teach as many as five groups simultaneously.

LOCATION

The project is located in an off-campus learning center at 733 West Hargett St., Raleigh, within easy access of students. Facilities are arranged to allow adult learners to study individually, both in a learning laboratory and at CAI terminals.

VISITORS

Educators, potential students and other interested persons are welcome at the North Carolina State University Adult Learning Resources Project. Visits may be arranged by calling the Adult Learning Center at Raleigh telephone number 755-2810.

Written inquiries should be addressed to the Project Director at 733 West Hargett St., Raleigh, N. C., zip 27603.

This publication is an extension of Project OEG-2-7-00390303903 of the Adult Branch, U.S. Office of Education. Prepared and distributed in furtherance of Section 309, Adult Education Act of 1966. Cooperating

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ABSTRACT

SMALL, HAZEL CHRISTINE. Effectiveness of Reinforcement Schedules in Relation to Certain Adult Characteristics Using Computer Assisted Instruction. (Under the direction of EMILY H. QUINN).

The objectives of this experiment were to assess: (1) the degree of relationship among reinforcement, learning and self concept for adults using CAI, (2) changes in learner performance with changes in reinforcement schedule, and (3) the contribution of self concept to changes in learner performance when reinforcement schedule is varied.

Data obtained from CAI self concept inventories, CAI individualized instruction in fractions and from paper and pencil pre and post tests in fractions was utilized.

The experimental sample consisted of three treatment groups; each group included 16 randomly assigned adult learners.

Three different schedules were utilized to test the effects of reinforcement: (1) knowledge of results only, (2) knowledge of results plus praise statements on a thirty percent random schedule, and (3) knowledge of results plus praise statements on a hundred percent schedule. A correlational independent variable, self concept as determined by P scores on the Tennessee Self Concept Inventory, was also utilized. Dependent variables included achievement, error rate, and latency rate.

Analyses of correlation, multiple regressions, and analyses of variance were done.

It was concluded that the sample of adults exhibited self concepts which were significantly lower than would have been preditced from randomly selected population scores. Within the total sample there was an indication that lower self concepts were significantly associated with a higher number of practice trials to mastery; gains were related to number of trials; and achievement was negatively related to errors.

Data indicated lower self concepts obtained greater achievement, took less time, amde fewer trials and fewer errors. Within treatment groups, significant relationships were indicated among self concept, one hundred percent reinforcement schedule, and these variables: achievement, trials, time and errors. A wider range coupled with a definite bipolar pattern of learner performance measures indicated that the thirty percent random schedule made a difference. The higher the self concept the more thirty percent random schedule effected high gains, more trials and mote total time.

Data indicated significant differences between correlations of self concept, treatments and all four learner performances: (1) achievement, (2) trials, (3) time and (4) errors.

When self concept was held constant, there was a

significant difference between the thirty percent random group and the knowledge of results group on total gains.

An examination of overall CAI performance indicated that those learners with the least enabling ability required more trials but made more actual gains without regard to self concept scores or treatment effects. A learning curve constructed from learners' error rates displayed a close correspondence to that predicted from theory. All groups exhibited a sharp drop in error rate and a leveling off over time. Based on achievement, the thirty percent random schedule indicate the most effective learning patterns of the three schedules tested for high self concepts; the one hundred percent schedule for low self concepts.

EFFECTIVENESS OF REINFORCEMENT SCHEDULE IN RELATION TO CERTAIN ADULT CHARACTERISTICS USING COMPUTER ASSISTED INSTRUCTION

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BY

HAZEL CHRISTINE SMALL

PUBLISHED AS:

RESEARCH MONOGRAPH NO. 3

ADULT LEARNING RESOURCES PROJECT
DEPARTMENT OF ADULT EDUCATION

N. C. STATE UNIVERSITY AT RALEIGH

JUNE, 1970

CE 004 859

PREFACE

One of the major objectives of the Adult Learning Resources Project is to communicate the findings and results of the Project's research efforts to concerned adult educators. This objective is being accomplished by conducting special workshops and training programs, holding orientation sessions, producing slides, films, tapes, and a variety of publications. One type of publication will be a series of research reports and monographs.

This monograph reports the problem, design, and findings of graduate student research directly related to the Project objective of adult basic education teacher training. Subsequent graduate research reports will be published and distributed upon completion in an effort to disseminate the findings of research pertaining to the Project objectives.

J. B. Adair

Project Director

June, 1970

ACKNOWLEDGEMENTS

This study was completed under the supervision of Professor Emily H. Quinn, who served as chairman of the author's graduate committee. The author is sincerely appreciative of the understanding, encouragement and guidance she received from the members of her graduate committee, Professors Emily H. Quinn, Edgar J. Boone, J. B. Adair and Charles G. Morehead.

The author is indebted to Professor Emeritus, Gertrude M. Cox who provided invaluable guidance to the statistical design and analysis of data related to the study.

Gratitude is expressed to the members of the staff of the Adult Learning Resources Center, including Mrs. Sharon Nichols, Systems Analyst, and Mrs. Earleen Vannorsdall, Learning Laboratory Coordinator, who gave so generously and freely of their time and assistance in administering the collection of the data for the study.

The author gratefully acknowledges the assistance and cooperation extended by fellow graduate and undergraduate students associated with the Adult Learning Resources Center. Without their assistance this particular research would not have been possible.

Finally, the author is especially grateful to her husband, Howard, who edited the manuscript and to her children, Douglas, John and Nancy, for their sustained encouragement.

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INTRODUCTION

The Problem

Scope of the Problem

This study examined one selected mode of Educational Technology--Computer-Assisted-Instruction (CAI)--as it relates to adult learners. The study examined the utilization of this concept to control the reinforcement schedule of adults enrolled in an arithmetic program at North Carolina State University Adult Learning Resources Center.

Problem Statement

In order to construct efficient instructional materials, educational technologists need to know the effects of various reinforcement schedules on the speed, accuracy and achievement scores of undereducated adults enrolled in CAI.

Purpose of the Study

The purpose of this experimental research project was to discover the probable significance of relationships existing between certain selected variables operating in a CAI situation involving undereducated adults.

The learning situation of students of the IBM 1500 Instructional System using an arithmetic program for adults at the Adult Learning Resources Center of North Carolina State

University located at 733 W. Hargett Street was utilized for this study.

Here, selected variables operating in the CAI situation were observed and measured from samples of undereducated adults. Factors were analyzed such that those which contributed to effective performance could be identified, measured and described.

Specifically, the purpose of this study was to assist in answering the question: Do different reinforcement schedules effect differential rates of learning, achievement levels, and error rates for different undereducated adult personalities in a CAI Math Program?

General Problem Area

What are the interrelationships between learning performance, reinforcement conditions and personality of undereducated adults? What reinforcement conditions affect the learning rate, the accuracy, and the achievement performance of undereducated adults? What are the effects on adult learners of different schedules of reinforcement?

The general problem area was analyzed to delimit the scope to expose only those specific questions which were felt to be the most appropriate for this study.

Information relative to the following questions was sought. What are the interrelationships between learning performance, reinforcement conditions and self concept values for undereducated adults? Does the learner's self

concept influence the effects of reinforcement? Is the effect of reinforcement a function of frequency? Within self concept levels, does the frequency of reinforcement affect performance? Can learner performance be predicted on the basis of personality and reinforcement conditions? How do variations in reinforcement affect learning?

Objectives and Hypotheses of the Study

The results of other investigations dealing with the problems of reinforcement variables, personality variables and learning outcomes have been taken into consideration in this study. However, other investigations were concerned with children or special groups of learners. This inquiry purported to investigate a different dimension, viz., the relationship between variables operating in a CAI situation for undereducated adults viewed from the standpoint of the professional educational technologist.

Findings from this study may assist in answering some common questions held by educational planners regarding the production of materials and the use of CAI for adult basic education. The findings may contribute to the growing body of knowledge regarding reinforcement theory; also, results may constitute a reference for the design and construction of CAI modules by educational programmers. The study may serve as a guide in analyzing causal factors in other learning situations.

Additionally, it may add to existing knowledge concerning the self concept.

The general objective of this study was to empirically determine the degree of relationship between reinforcement, learning and self concept for undereducated adults using CAI. Specific objectives of the study were:

1. To identify and describe the contribution of certain factors to adult learner performance using CAI at the Adult Learning Resources Center by comparing sample groups of adult learners on selected academic performance and personality variables, under selected reinforcement treatment;
2. To measure changes in learner performance with changes in reinforcement schedules;
3. To identify and describe the contribution of selected personality attributes to changes in learner performance when reinforcement schedule is varied;
4. To measure the combined effect of reinforcement schedules and selected personality factors on learner performance.

In order to test the effects of this experiment, the following hypotheses were set up:

Hypothesis I. There is no significant difference among the continuous reinforcement, non-reinforcement, and varied reinforcement treatments on the following criterion measures:

a. Achievement

b. Time to complete the program

c. Error rate.

Hypothesis II. There are no significant correlations between self concept scores and the following criterion scores:

a. Achievement

b. Time to complete the program

c. Error rate.

Hypothesis III. There are no significant correlations between the variables, self concept and reinforcement schedules, investigated in the experiment for the following criterion measures:

a. Achievement

b. Time to complete the program

c. Error rate.

Limitations

The nature and characteristics of the Project (OEG 2-7-003903-3903) placed certain limitations on the population, the sample and certain factors of the learning situation in terms of this study.

The population from which the sample was drawn was restricted to those adults who voluntarily enroll for instruction. Learners were restricted to adults 16 years of age and older with less than a high school education, who adhered

to various attendance schedules for instruction contingent upon the time they had available between the hours of 8 A.M. and 10 P.M. Monday through Friday.

The sample selected was restricted to those learners of the enrolled population who placed at D level of the IPI Math program. This included those who scored less than 20% on the E level of the IPI diagnostic math tests or those who scored 85% or above at the C level. Placement diagnosis indicated that the learner possessed those enabling skills necessary to be able to perform those operations to be learned at the D level. The placement test did not supplant the pre-test for level D. Rather, the pre-test measured the number of the skills embedded in level D that the learner could already perform before instruction started.

Maintenance of the sample size was by adding randomly assigned replacements for drop outs.

The nature of the research investigated in terms of the resources available, IBM 1500 system equipment, project goals as well as learner motivation and time, restricted the duration of this study to the time it took the learners in the study to accomplish five fraction skills of the IPI program.

No attempt was made to apply the findings of this study to other instructional modes such as programmed instruction or group instruction or to other populations than under-educated adults enrolled at the Adult Learning Resources

Center.

The statistical techniques used in analyzing the data were confined to multiple regression and correlation, analysis of covariance, LSD tests, Z tests and analysis of variance.

Background Information and Rationale for Study of the Problem

In an assessment of the status of education as an historical tradition toward the solution of current problems, Lyndon B. Johnson (1968, pp. 7-9) recently stated that "even though the United States has achieved one major educational advance after another in the last two centuries," and further, even though we,

> Already are seeing the fruits of the commitment in the lives of millions of Americans, young and old, whose lives are being shaped by new educational programs....yet for all our progress, we still face enormous problems in education.... equal educational opportunity to the poor family in Appalachia and to the negro family in the city is still a promise-not a reality.
>
> The challenge of our generation is to lead the way....to.... four essential freedoms for which America stands - the freedom of speech, freedom of worship, freedom of want, and freedom from fear....we have declared another essential human freedom - freedom from ignorance. Everyone everywhere, should be free to develop his talents to their full potential, unhampered by arbitrary barriers of race or birth or income....We have begun the work. The job, of course, will never be finished. For a nation as for an individual, education is always an unfinished journey....

According to the National Census, more than 24 million adults in the United States have less than an eighth grade education; in addition, untotalled others are functionally

illiterate. At least 3 million adults, age 18 and over, have had no formal school experience (U.S. Census, 1960). Such a magnitude of illiteracy within the total population of approximately 200 million has contributed to social stress of crisis dimension. Civil rights confrontations, protest, demonstrations, crime, situations of rioting, violation and destruction of human life and property are becoming common (Kerner, 1968). Latent interrelated conditions of ignorance, slums, poverty and unemployment are suddenly critical. Gordon, (1965) and Broger and David, (1962) found that failure of the poor to either constructively participate in the affairs of modern society or to share in the material rewards of participation, much less to fulfill the expectations associated with value orientations of middleclass society, result in undesirable consequences which effect individuals, groups, organizations and the total society.

The conditions of ignorance, poverty and unemployment are related to income distribution, level of national economy, manpower needs, technological change, levels of education and other demographic characteristics. (Economic Report of the President, 1964). The knowledge explosion since 1940 has promoted industrial automation. Automation in turn has produced shifts among industries, occupations and geographical sites for labor which are reflected today in labor needs being product-moment oriented. Manpower

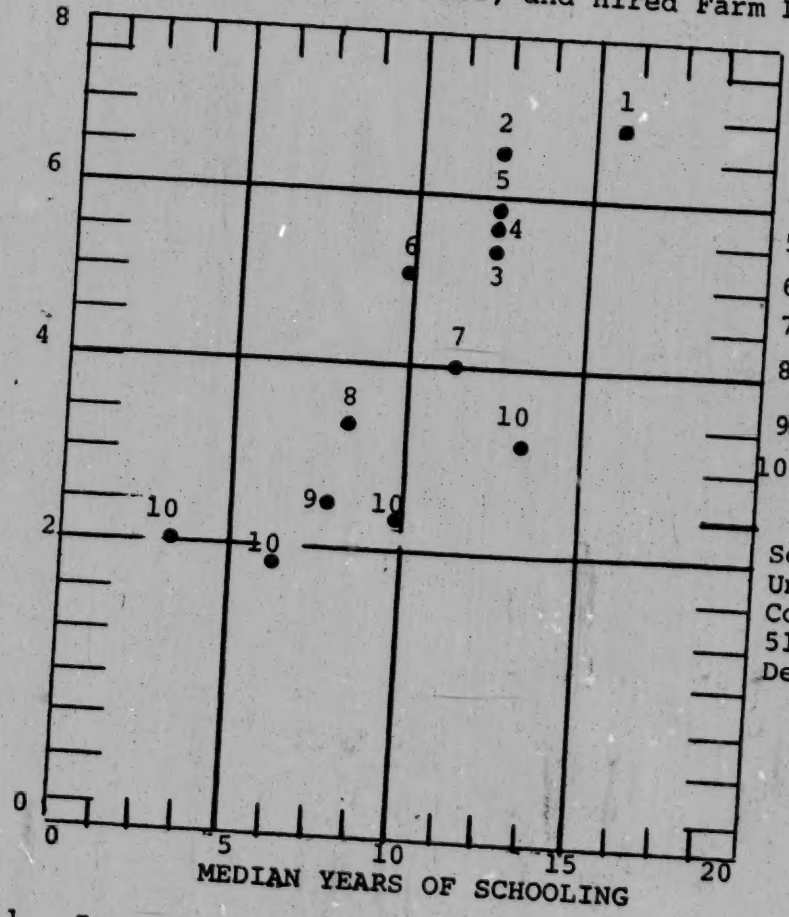
needs then become dependent upon the state of the technology and require an increasing level of technical competence.

Education and skill requirements tend to be greater for those jobs which are left in an industry when "automation" is substituted for labor. One or two highly trained workers may fulfill the job requirements now where previously several unskilled workers were required. The worker lacking training or basic education needed for training is soon unemployed (API, 1968, N.C.S.U. Report on Poverty). Thus, the illiterate man or woman lacks the prime requirement for self-support.

There is a direct relationship between education and occupation. Figure 1 indicates that occupations open to the illiterate are limited (API, 1968, N.C.S.U. Report on Poverty, p. 22).

Data from the Kerner report show that education and income are related sufficiently within categories that knowledge of one predicts the other. Nonskilled occupations which require little or no education comprise nearly 30 per cent of the labor force. These job categories produce family incomes with a median of $3,436 or less. At lease 20 per cent of the labor force earns less than a median of $2,500, a sum below the income baseline separating poverty status from non-poverty status (Kerner Report, 1968). Additionally, "In 1967, approximately 3.0 million persons were unemployed and received no earned income during an average week. This figure represents an unemployment rate

All U.S. Males, 1962, and Hired Farm Labor, 1961



1. Professional & Technical
2. Managers, Officials & Proprietors
3. Clerical & Kindred Workers
4. Salesworkers
5. Craftsmen & Foremen
6. Operatives & Kindred Workers
7. Other Service Workers
8. Laborers, Except Farm
9. Farmers & Farm Managers
10. Farm Laborers, Individual Observations

Source: Statistical Abstract of the United States, 1964 (U.S. Dept. Commerce); Agr. Econ. RPT. 51 and AGR. Hand B. 275, 1964 (U.S. Dept. Agr.

Figure 1. Income and schooling by occupational groups

of about 3.4 nationally. Warner (1941) indicated that a lack of education opens the door to only undesirable jobs which have low pay, low status, instability, uncertain tenure, and little chance for advancement. At least 1 per cent of the population are "hard core" disadvantaged.

Educational skills which provide the capacity to get and hold a job is the test of participation in American society. Daniel P. Moynihan (Kerner Report, 1968, p. 252) has said that holding a job is "The primary source of individual or group identity....to do nothing is to be nothing."

Education, employment and income are also related to social welfare. The incidence of many socially deviant behaviors and physical handicaps such as crime, narcotics, illness, anomie, suicide, apathy and depression is concomitant to unemployment and poverty from low income unskilled occupations. Orshonsky (1965) has shown as in figure 2 this relationship.

The effects of conditions of ignorance and unemployment and the resultant life-style of poverty are cyclic, or as Sapir (1949) put it, "deep seated culture patterns." They are transmitted from parents to children almost as deterministically as is genetic inheritance. Such an environment produces a sub-culture of behaviors which exhibit motivations, levels of aspirations and goals not usually conducive to educational attainment (Havighurst, 1944) Davis has concluded that father's occupation is one of

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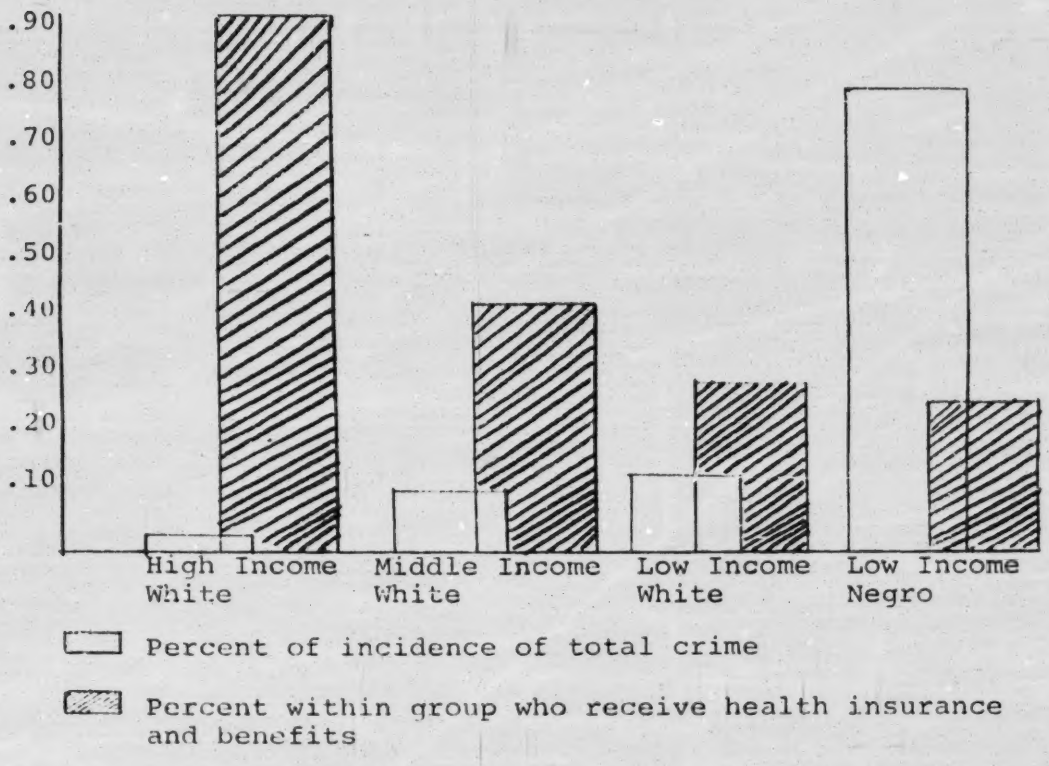

Figure 2. Relationship between income, race and incidence of crimes committed against persons, and the use of health insurance benefits within income groups in large cities in 1965

the main correlates of the level of educational attainment and occupational goals (Kerlinger, 1964).

The self-generative nature of an illiterate culture of poverty within a greater culture of ascending affluence and exploding knowledge accumulation promises to continue to produce a widening gap between social classes and a predictable increase in social and economic stress. Civil disorder

and the other by-products of alienation from society can only become more costly and devastating to all members of society (N.C.S.U. Report on Poverty, 1968 and Economic Report, 1964).

National attention has been focused on the problem of reducing the effects and the incidence of illiteracy and unemployment by initiating a myriad of various welfare programs. A brief historical perspective of some of the major programs indicate that they have been narrow in scope and have proved to be inadequate to meet the long range challenge of social change (Reisman, 1950). Unpredictable changes in all the elements of society and at all levels; local, regional, national and global is the trochee of dynamic modern society (Mannheim, 1936 and Dewey, 1916). Some of the early programs initiated to stem unemployment and its ramifications include the NRA of 1934, the WPA of 1936, followed by Farm Price Supports and the Social Security Act of 1935, the TVA and Rural Electrification, the CCC of the 1930's, the FHA (N.C.S.U. Study on Poverty, 1968).

After World War II, the Veteran's Administration and the Small Business Administration broadened the base of federal concern and assistance to individuals and groups with employment and educational needs (American Heritage, Volume I, 1967). The above programs reflect implicit employment and economic problems and corrective

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legislative attempts at a national level to resolve them (Leviton, 1966). Concurrently, the social philosophies and values such as "Chicken-in-every-pot", "New Deal", "Fair Deal" and "Square Deal" reflect and sympolize the presidential platforms of Herbert Hoover, Franklin D. Roosevelt, and Harry S. Truman respectively, as each sought for concerted national attitudes (American Heritage, Volumn II, p. 870, 1967).

Industrial and occupational reforms initiated at the national level designed more for social welfare since Hoover's administration have included Minimum wage and Maximum hour laws, collective bargaining for trade unionists, parity prices for the farmer, relief and public works for the unemployed, support of CIO and organized labor (American Heritage, 1967). Training and industrial reforms have focused on man-power training programs subsidized by the government for defense purposes during the war, Workman's Compensation, Child Labor laws and Housing projects (Reader's Digest Almanac, 1968). The described programs often focused on reducing poverty, protecting the rights of workers from industrial exploitation, putting the assurance of money into the economy by supporting private enterprise but they did little to increase the opportunity of employment on a long term basis. The aims and purposes were to alleviate and ease the conditions of poverty rather than to strike at the causes of poverty. As Cohen, (1965, p. 287) has stated:

> First, there is the organization of programs along categorical service lines rather than in ways which facilitate the solution of multifacted human problems.

With the passing of the Morrill Act of 1862, the development of educational reform programs have generally reflected the industrial, political, social and philosophic trends of the nation. Despite the commitment and influence of leaders and philosophers such as Thomas Jefferson, Charles Beard, George Counts, Charles Peirce, Horace Mann, John Dewey, Theodore Brameld and others, -men who felt that the ends should be for the purpose of social reform rather than reflection of social forms, humanistic values and equal access to the sources and consequences of education are yet to be realized (Counts, 1952; Howe, 1968; Dewey, 1916; and Brameld, 1963). The roots of most of our traditions are bedded in the scientific, (natural and social) political and religious values of Middle East origin (Rugg, 1955).

In the process of growth, the nation has gathered its strength by exploitating and utilizing environmental and human resources (Gibson, 1968). The economical and political systems of society, along with borrowed and created social and technical systems, have expanded and become more complex as they have been made to serve the needs of a growing industrialized nation (Counts, 1952). Harold Howe has hypothesized that as we have moved from a rural to an urban society certain forces point up "the essential relationship between education and every aspect of our national life and national welfare" (1968, p. 7). These forces are felt in the magnitude of the expansion of our economy, the

increasing plurality and egalitarian nature of national politics and governmental functions, and in the broadening base of social welfare wherein more and more of the fundamental or basic-needs requirements of all citizens are included (Spindler, 1955). The relationship is supported, in part, by societal faith in the process of education to be the means of the attainment of "higher intelligence" and the good life. "The image of education," as Metraux has said, 'opens doors', 'new vistas' or 'wider horizons' (Rugg, 1955, pp. 2-46).

Social action based on faith in education has been operationalized by legislative provisions for both compulsory free education for the masses, and for assistance to institutions, agencies and programs representing the broad spectrum of public and private educational opportunities for adults (Friday, 1968). Within the past five years, "Congress has approved more than forty laws to support education from the pre-school project to the post-graduate laboratory; the federal government has raised its investment in education to nearly $12 billion annually" (Howe, 1968). These and other legislative provisions of laws, titles, and acts have boosted education to serve in two ways in support of the Great Society (Johnson, 1968). On the one hand, education has served to provide the masses, both nomothetically and idiographically, with the intellectual skills essential to facilitate socialization and a better life (Ginsberg,

1966). In fulfilling this function, the educational system has reflected the selected value system of the majority of the early leaders. Values based on Judeo-Christain ethics, resulted in a controlled public education system to provide instructional programs of a narrow and rigid range to transmit the cultural heritage in quantity: A system offering a proliferation of more and more specialized courses to more and more students (Tyler, 1968). On the other hand, as the national level of socialization rose after successive generations of school children, the cumulative characteristic of knowledges, skills and abilities in the cognitive affective and psychomotor domains became manifested on a national level as "modern society" (Watson, 1968 and Bloom, 1965). Today we are mainly a literate nation. Our main business has become the transaction of knowledge (Gores, 1968).

Where once the knowledge of the world could be contained in but a few manuscripts, today no facility is adequate to store the world's knowledge. No professional can begin to know all the information about even his own speciality. Individual attempts to have access and ability to process information of any but a limited depth is almost impossible. Therefore, the selection, organization and distribution of knowledge within the educational system is a crucial issue today. A recent report of the subcommittee on Economic Progress of the Joint Economic Committee, to the 89th Congress, Second Session stated the need for educational and informational coordination (Mass Media, p. 87):

> Recent developments in such technological aids as educational television, videotape, computerized instruction, microfilms, and talking typewriter, have the potential to revolutionize the American system of education, to alleviate socio economic ills, and to eliminate adult illiteracy. However, long range benefits will depend greatly on basic and applied educational research....

The ascending level of intellectual competence in all areas of human concern has resulted in both a greater global potential of power to act and also in a greater freedom to choose from alternative future courses of action (Powell, 1968). These dimensions of power and freedom and the awareness of their strengths has been so recent that for most purposes it dates from World War II (API, 1968, pp. 75-76).

The operational definitions by which "our world" is known have changed so often and so fast that one of the most stable concepts of today has become that of "change" (Ginsberg, 1965). Space and time are becoming more finite; conceivably they will cease to be bases of measurement and knowledge. The concepts of life, death, and chance may drop from pragmatic reference and become instead the basis for future myth and fiction. Human problems develop with adjustments to change.

In attempting to predict the emergent society of the future, an anthropological comparison of the realities of today with their origins identifies trends and serves to suggest the most likely changes that will occur (Ibid, 1965). These predictions among others, indicated technology and automation will increase, instant communication and

transportation are possibilities, rural and provincial ideology will no longer exist, and finally, the social, organic and phenomenological systems of our environment will become more rapidly controlled (Powell, 1968). Men will be living in an increasingly affluent society.

Such predicted social changes as those mentioned above have emerged and accompanied man's movement from a state wherein he lived a tenuous life subject to the forces of his environment and one in which he was almost self-supporting and socially independent, to a state wherein he now enjoys a more viable life though socially dependent in a controlled environment (Knowles, 1962). Such a movement means, among other things, that both man and his controlling society have different needs than formerly (Benedict, 1934). Social planners such as men like: Mangum, Frazier, Kellogg, Levitan and others are concerned with social problems stemming from technological change. One of the greatest problems is that of including the total society in the movement (Mangum, 1966).

In defense of the theory that intelligence is randomly distributed among the population and that therefore all men can learn if they have access to the opportunity; and in refute of the theory that "the poor and unemployed will always be with us because some people are just naturally ignorant - it runs in the family." Ashley Montague (1964) has said:

> The danger of theories of race is that they are created as rationalizations which over-extend

> physical differences to apply to 'inherited' traits of intelligence and virtue.
>
> It is alleged that something called 'race' is a fixed and unchangeable part of the germ plasm, which transmitted from generation to generation, unfolds in each people as a typical expression of personality and culture.
>
> Such theories arise from emotion, defensiveness and ethnocentricity: in Aristotle's defense of slavery, in the justification of the slave trade by Europeans, in the 'white-man's burden' of colonial times....
>
> ....the highest mental abilities in any group-those who are adaptive, flexible and wise.... a complex group of traits which together produce 'intelligence', genetic factors such as produce physical traits are less determinative. Intelligence, from the genetic standpoint, is not so much a product of major genes....

Ruth Benedict (1934) has discussed man's changing behavior in respect to his culture:

> Culture is not biologically inherited, but it plays a major role in the formation of individual patterns of behavior. Customs can be changed by the men who formulate a culture and should be changed as the men who formulate the culture become increasingly sophisticated.

Despite the possible affluent good life, provisions to sustain it, and the potential in storage for all of mankind, today at least 24 million adults are still undereducated and cannot possibly participate in modern American Society. Their futures are dubious (Miller, 1967). They are illiterate. They do not possess the intellectual skills nor the competence to have access to the skills needed to participate in a knowing society. The loss of this human resource from the mainstream of society is too costly a condition to perpetuate (Bishop. 1968). The illiterate,

the unemployed, and the poverty stricken have become a great problem of our time. Paul Miller (1967) has asked:

> How can the institutions of society meet the needs of society and its citizens to improve the conditions of man?

If the link between modern man and his rural ancestors lies in the possession and use of knowledge, then some way must be found to provide economical and effective instruction to this population. In this respect, John Galbraith (1958) has said:

> Educational programs offered through the regular classroom cannot keep pace with the increasing needs of more than 24 million adults.

Commenting on the relationship between need and the process of education, Allison Davis, (1948) as a result of his studies here and in England, states:

> ....undereducated educational needs may be different than middle class instructional strategies provide for....

Educational programs offered through conventional classroom methods alone cannot meet the needs of undereducated adults. Of the estimated 24 million adults in need of remedial education, only 400,000 were enrolled in 1967 (National Advisory Committee, 1968).

ABE instruction loses much of its impact when teaching methods hold a learner to the traditional mold in which he may have already failed. Such restraints cause dropouts from the program and point out the need for more efficient learning methods for adult learners.

Extensive use of new educational technology may offer new ways of reaching larger numbers of adults at a lower cost per student.

Learning experiences may be made substantially more meaningful for the undereducated adult by the use of instructional strategies that utilize self-directed and self-controlled learning experiences. Media used for adult learning experiences may take many forms, including programmed instruction and computer assisted instruction. Other audio-visual media including the video-tape recorder and closed circuit television, can be used to effect and reinforce learning. In short, a multi-media approach can provide meaningful and efficient learning experiences for adults.

Programmed instruction, as one form of self-directed study, might be more extensively used in providing educational experiences for undereducated adults. Values that accrue from programmed instruction may be enumerated as follows: (1) more economical in terms of cost per student as the same material can be used with a large number of adults; (2) psychologically suited to the needs of undereducated adults in that they can experience immediate success; (3) reduces the authority figure as the teacher becomes a monitor working alongside the student; and (4) reinforces the feeling of self-worth and independence (Glaser, 1966 and Thomas, 1964).

The use of Computer-Assisted Instruction (CAI) also circumvents many of the inadequacies of traditional instruction, thus providing the adult learner opportunities for instructional "interactions" without the possibility of potential embarrassment before a group of his peers. The method involves a fully-integrated, multi-media approach in which appropriate remediation and feedback are administered to the adult learner immediately after his demonstrated need for them. CAI insures that the learner actively responds to instructional materials, rather than passively listening to them. Immediate "success experiences" can be provided by the sequential presentation of small conceptual "chunks" of information which requires the adult learner to respond to each step in the sequence (Gerard, 1967).

Just as educational technology is being enlisted in some of the more pressing problems facing the nation's public schools, the use of technologies such as programmed instruction and computer assisted instruction might help meet the need of adult basic education to reach more adults more efficiently. These media offer ways of extending resources--human and material--over a wide area; they offer the means of teaching more subject matter to more adults more efficiently; when used wisely, they can relieve the teacher of routine duties and free him for those tasks which only one human being can do in close relation to other human beings. Even more importantly, they can free each learner to do more work more independently.

Educators responsible for adult basic education are confronted with the dilemma of providing for the massive numbers of undereducated adults who would profit by participation in their programs, and the lack of suitable instructional methods and materials for educating larger numbers of adults. Research is needed to provide teachers and theorists with information on the conditions under which adults profit most from instruction by CAI.

Evidence assessing the capabilities of computer assisted instruction as an aid to the educational process is slowly accummulating. Educational technology include the application of digital computers to data processing has received considerable attention in the last decade, more recently attention has been focused on its use in the teaching-learning situation. Richardson (1969) has summarized these functions to include three categories, (1) The Curriculum, (2) Direct Aid to the Instructional Process, and (3) Those Related to the Instructional Process. i.e. counseling, research, etc.

Projects such as the "Developmental and Demonstration Project in the Use of Modern Educational Technology for Instruction of Undereducated Adults", OEG 2-7-003903-3903 of the Division of Adult Education, under the provisions of Section III of the Elementary and Secondary Education Action Provision of 1966, conducted by the Adult Education Department of North Carolina State University at Raleigh, North

Carolina is designed to contribute research to the problem of national adult literacy (OEG Project, p. 17). This present study on reinforcement contingencies is being conducted in conjunction with that project and its objectives: (1) To identify instructional strategies to improve the efficiency to present educational programs for adults, (2) To identify effective and economical ways to provide individual learning experiences that will accelerate learning for large numbers of adults, (3) To explore the capabilities of computer assisted instruction that utilizes self-directed and self-controlled learning experiences.

Studies concerned with the effects of feedback, and reinforcement schedules, Erickson (1967); Gilmore (1967); Hall, Adams and Tordiburo (1968); Hunt (1961); Newton and Hickey (1965); Anderson, Faust and Roderick (1968); Cook (1960); Campean (1968); Guthrie and Lunsdaine (1961), et.al. indicate attention in CAI research is directed toward learning populations other than the illiterate adult. Most studies focus on school children, therapy groups, armed services, graduate students and industrial training. CAI Research directly concerned with the undereducated adult is needed.

Relationships between man's behavior and his environment, his society, institutions, democracy, national economy, poverty, illiteracy, education, teaching and CAI are intimately controlled by the learning process. Skinner (1953) sees the conception of a free, responsible individual to be embedded

in our language and pervading our practices, codes, and beliefs - but as an unexamined conception. He feels that behavior can be studied, laws can be derived and a science of human nature can be perfected. Such a science requires research into the conditions under which behavior occurs.

The concept of the learning process indicates a relatively permanent change in behavioral tendency. The process includes a learner, a stimulus situation and a response. Learning is assumed to have occurred when a behavior change can be observed. The concept rests on some assumptions about the learner's psychological and physiological states necessitating other concepts such as need (Havighurst, 1952, Miller, 1967, Erickson, 1950) and perception (Hull, 1963, Allport, 1955 and Bruner, 1947).

Thorndike and Skinner (1953, pp. 59-65) viewed learning as a "shaping" of behavior by an association process between a specific stimulus and a response.

Tyler (1950) defines learning as the process of interaction between the learner and the external conditions in the environment to which he can react.

Spicer (1952) and Biesanz (1964) feel that the social class to which any individual belongs prescribes patterns of behavior - a life style which provides a frame of reference within which the motivations and perceptions are directed toward social-psychological, prescribed behavior. The social class delineates educable responses.

The undereducated adult possess cultural characteristics which are distinct from other social groups which may influence the learning process. Case studies as reported by a seminar conducted by faculty members from the Behavioral Sciences of North Carolina State University indicate these adults to exhibit unemployment, poor health, high birth rates, degeneration of home and family life, racial discrimination, and inter-generation transmission of these traits, failure and despair attitudes, social and personal frustration, low self concept, feelings of inadequacy and unworthiness. They lack incentives and motivation to formal education. They need immediate rewards for any behavior. They place low value on education, saving and social advancement (West, 1968). They lack proper speech patterns and the tools of intelligence such as verbal abilities to generalize, synthesize, apply theories, analogies and communicate according to acceptable rules of language.

Research relating learning theory and the individual characteristics of age and intelligence is needed. According to Louderbach and Tate (1969) early studies on adult learning reported that the curve of intelligence increases with age to the early twenties and is followed by a constant but slower decline throughout the adult years. More recent studies indicate scores do not follow this pattern when tests are administered to the same person as he grows older.

One of the more recent investigations in this area was conducted by Nancy Bayley (1960) whose longitudinal studies indicate that at least some intellectual abilities may continue to improve slowly from 20-50 years of age or older. Bayley also suggests that older persons do relatively better in tests of information and word knowledge, and less well in tests of reasoning and seeing relationships.

These findings were supported by Schaie in 1958 and Bilashand in 1960 (Guilford, 1967, p. 450), when they found that memory remains high until 45 or 50 years of age, then declines rapidly.

Monge and Hultsch (1968) report that older men did not recall as much as younger men in a recent experiment but that what they did recall was as well organized as that of younger men. They indicate a need for more research in the area of personal characteristics and learning performance.

Controversies continue on whether differences in intelligence are hereditary or caused by environmental factors. An important physical basis for the intellectual status of the individual is found in the genetic material (Chromosones-DNA & RNA) that directs the development of the nervous system (Guilford, 1967, p. 347). Studies on the chemical conditions of the brain continue under investigation in connection with intellectual functioning but results are yet inconclusive.

In support of the premise that the environment and its restraints effect learning, Guilford identifies some inhibiting conditions of the environment as more or less permanent

deficiencies of the young during infancy, lack of attention or of intelligent models, and poor educational opportunities (Guilford, 1967, p. 410).

Through individualized instruction some of these seemingly permanent characteristics may be modified; thus changes in the standard of living can be improved.

Research indicating the strength, duration and effects on these relationships is needed to implement more effective instruction in the undereducated adult population.

Research pointing up relationships between learning and personality characteristics is needed. Puder and Hand (1968) have hypothesized that a man's self concept determines his learning behavior.

Brookover (1964), Bruch and Boldwin (1962), Shailer, Patterson and Brookover (1964) have found a positive correlation between self concept and performance in the academic role (Landsman, 1962). They support the assumption that personality attributes are related to educational achievement.

In this respect Landsman states: (pp. 285-295)

> It (the self) is the central aspect of personality.... Learning....is determined, influenced, distorted by the (learner's) view of self.

A more developed study by Jackson and Strattner (1964) supporting this finding, reveals:

> (1) Learning effectiveness is impaired by various forms of psychological pathology,

(2) Membership in a socially deprived group or in a stressful family environment creates a threatening situation....
(3) Learning is enhanced by....positive attitudes.... and feelings of self confidence.

The undereducated adult with a self image of having little power over his own environment and being illiterate and unworthy may not have the emotional ability to learn as fast or to the degree of adults with a stronger self concept.

Studies have focused on identifying relationships between environment and personality attribute of the undereducated; other studies have focused on relationships between environment and educational achievement. Research is now needed to identify significant relationships between personality attributes and learning abilities for the undereducated adult population.

Within the adult Education field, research concerning the teacher, the learner and their interaction patterns within the community environment is a recent major thrust as a result of: (1) the Economic Opportunity Act of 1964 and (2) the Adult Education Act of 1966, Title III, of the Elementary and Secondary Education Amendments of 1966.

The long range plan of research, 1968-78, of the Department of Adult Education of North Carolina State University illustrates cognizance of the need for research in adult basic education. The objectives of the Research Committee include studies of: (1) The effect of Adult Basic Education on Occupational Adjustment and Acculturation;

(2) Psychological and Sociological Factors associated with the Adult Learning Process; (3) The Role of Educational Technology and Media in Teaching Undereducated Adults; and, (4) Exploration of the Teaching-Learning Process in Adult Education.

The need for research is reflected in studies being conducted at the state level through pilot projects as reported by Harold Howe on behalf of the National Advisory Committee on Adult Basic Education in a recent letter to the President (First Annual Report of the National Advisory Committee on Adult Basic Education, 1968).

The current and historical perspectives, as presented above, indicate the scope of the problem of the undereducated in our society. The relationship of illiteracy and poverty and the effects of that relationship on the elements of our social system have been discussed. The relationships between the national design, basic philosophy, national economy and concomitant social conditions (and especially the trends affecting the health, education and welfare of citizens) have been treated. A crucial problem then, confronting the national program of adult basic education, is the identification of faster and more economical ways to provide more numerous and more effective individual learning experiences to larger numbers of adults.

There can be no doubt that a consensus of concern has prevailed in this and other times over the State of the Union and the norms of literacy. Nave (1969) has pointed

out that there is great need for attention to the literacy problems of adults by the social and behavior science researchers.

Research is needed that will contribute to immediate and long range plans addressed to the situations of adult illiteracy and of crucial economic and social problems. Research as in innovative educational programs using many forms of educational media and technology are needed to promote a sound basis for these plans.

Research is needed to evaluate the effectiveness of educational technology such as the IBM 1500 Instructional system. The dearth of research directed to comprehensive aspects of adult basic education and particularly the application of selected principles of reinforcement theory operating in a CAI learning situation, serves to emphasize the need for studies such as this.

SOURCE AND ANALYSIS OF DATA

Population and Samples

This study was primarily concerned with undereducated adults enrolled at the North Carolina State University Adult Learning Resources Center located at 733 W. Hargett Street, Raleigh, North Carolina.

The comparisons of various learner variables and learning process variables as stated in the general objectives were made between the learners (Ss) by randomly assigning all Ss in attendance during February, 1970, who placed at Level D-fractions on the IPI placement tests, to one of the following groups; (1) continuous reinforcement, (2) variable ratio 30 percent reinforcement, and (3) no reinforcement. The latter group constituted the control group.

This experiment investigated the effects of different reinforcement schedules for responses on CAI learning performance by adult basic education students with varying self concept scores.

Dependent Variables

The experimental S's were observed on the following criterion measures:

(a) achievement gain as measured by a post-test,

(b) Enabling level as measured by a pre-test,

(c) Time in minutes required to complete the program,

(d) Number of errors in the program,

(e) Number of trials to acquire 100 percent mastery of five basic skills in fractions,

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(f) an achievement index computed as follows:

$$\frac{\text{Post-test minus Pre-test [gain]}}{\text{100 minus Pre test [needed]}}$$

The dependent variables were evaluated for significant correlations by an analysis of covariance technique.

Random Assigned Independent (Positive Reinforcement) Variables

A. Schedule, fixed ration 0 percent

B. Schedule, variable ratio 30 percent random

C. Schedule, fixed ratio 100 percent

Three programs of 50 problems each were constructed to cover five basic skills needed to solve simple fractions. Each treatment program presented knowledge of results; the variation between programs was in the schedule of positive reinforcement of praise statements:

Treatment A: Knowledge of Results Only. For each of fifty arithmetic problems designed to teach skill in solving simple fractions a correct or incorrect indication was presented to S's on the CRT.

Treatment B: Positive Praise Statements on a 30 percent Variable Schedule. This program was identical to program A except that in addition to correct and incorrect knowledge-of-results, on the average, positive praise statements were presented to S's 30 percent of the time.

Treatment C: Positive Praise Statements Continuous Schedule. This program was constructed so that S's were

provided reinforcement of knowledge of results and a positive praise statement 100 percent of the time (for each and every response.)

Personality Variable

Self assigned - S's were measured and compared on the characteristic of self concept to study the differential effects of levels of self perception on the criterion measures. S's came to the study already possessing this characteristic. Due to environment and other circumstances it is already a part of individuals, in varying degrees, when they come to the research situation. Self con-cept scores were assigned on the basis of performance on the 1965 Tennessee (Department of Mental Health) Self Concept Scale.

The P score of the Tennessee Self Concept Scale was computed for each S. This score was correlated to all criterion scores.

Learner Data

The various types of data as outlined in the objectives were collected from the following sources: (see Figure 3)

Upon enrollment in the Learning Center all subjects were administered a battery of tests and inventories. These were included and considered in the framework of this research.

(1) Achievement was determined by pre and post test scores of the IPI D and E level tests, also pre and post scores as measured by; the Adult Basic Learning Examination (Harcourt World and Brice) or Pre and Post scores of the California Achievement Battery (California Test Bureau).

(2) Learner personal data was collected upon enrollment by the Learning Center Admission and Enrollment Questionnaire.

(3) Self concept was determined by the P score of the Tennessee Self Concept Scale (Clinical and Research Form). The entire Scale was administered, but only the Positive scores were considered in the framework of this research.

(4) Accuracy was determined by the computer recorded tally of all correct responses for each S from zero ability to acquisition (95-100 percent mastery).

(5) Rate of learning was determined by computer controlled tally. S's total time from zero ability to acquisition was tallied in tenths of seconds. A score of 20 percent or less at initial placement was called zero ability. Acquisition was 48+ correct responses to 50 problems.

(6) Error rate was determined by computer tally and print out of all errors for each S from zero ability to acquisition.

(7) Trials in groups of 10 was tallied by the computer and recorded in sessions of 50 trials.

(8) Pre and post test scores determined from IPI published tests was recorded by the proctor.

(9) Achievement gains were determined by computing the post and pre-test difference.

(10) Achievement was the ratio of actual gain to needed gain for complete mastery. It was computed and expressed as a percentage.

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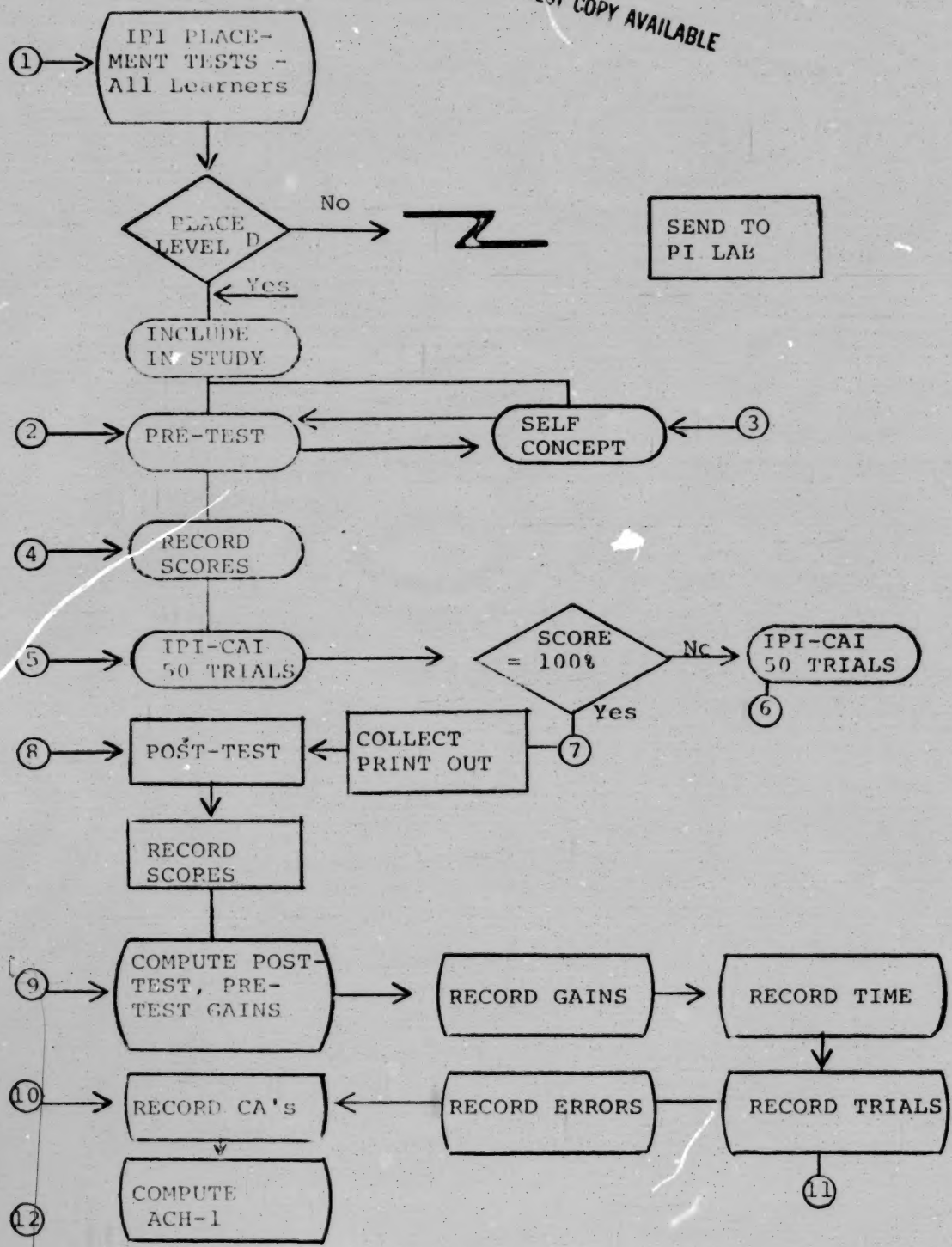

Figure 3. Procedural flowchart indicating sample selection, data sources and recording of data

Content Characteristics

Ss interacted with the material by using the keyboard or the light pen, each provided as part of the normal IBM 1500 System equipment in each student terminal.

The IPI program was chosen for this study because it has been developed as a research tool for both applied and methodological research in the field of Education and Psychology, therefore it seemed appropriate. It lent itself to CAI adaptation, permitted an experimental study such that variables operating in the acquisition of a skill could be controlled and measured. The program had both internal and external validity as well as reliability according to the published reports. By virtue of the nature of its development, the program had already been revised, debugged, and field tested by both the public schools of Pittsburg and by the RELCV of Durham, North Carolina.

The program was composed mainly of the constructed-response type student interaction, (type in answers) but Ss occasionally used the light pen. Each item in the lesson was so constructed that Ss had to understand the critical point of the frame before emitting the correct response. Each S was allowed to pace himself. Finally, the frames were so constructed that the S's probability of emitting the correct response was high. (Appendix B)

The items for the criteron test were those constructed by the IPI developers. The test items, also the constructed-

response type, covered all of the skills taught in each lesson (Appendix B).

All S's selected for this research were regularly administered CAI instruction on seven different areas of arithmetic (addition, subtraction, etc). The program employed was the D level in the area of fractions, IPI, a commercially prepared programmed group of lessons of Basic Math Skills used in the public schools of Pittsburg, Pennsylvania, published by Research for Better Schools, Philadelphia. The total program for a S in this research was individualized. It included a minimum of 50 problems but varied in length according to needed remediation (additional trials) for acquisition. Ss were permitted their time to acquire five skibls, after which they were post-tested by the IPI achievement test.

Data Collection and Recording

All data listed above for this research was entered into the learner's permanent file via student assigned number stored in the IBM 2310 Disk Storage. Personal daca plus personality data collected from the Self Concept Scales administered usually upon enrollment, were coded, translated to punched cards, and read into disk storage by staff personnel.

Data retrieval from storage for purposes or analysis was automatic from prescribed macro and numbered assignments programmed into the system before the research initiation. Additionally, the content, remediation branching,

as well as problem generations adapted from the IPI programmed soft ware tests will be programmed into the system prior to the experiment.

Data Analysis

Scores representing the effects of various reinforcement schedules on learner performance, and the effects of personality attributes as outlined in the objectives were analyzed to disclose the statistics of means, variances, and coefficients of correlation. Percentages, frequency polygons and other such appropriate graphic methods were applied to describe the adult learners in terms of quantitative measures and qualitative measures and qualitative variables.

Procedure for Administering Experimental Project for Adults with IPI D Level Fractions

1. Each learner who placed at D level fractions as a result of IPI placement tests was included in the study.
2. Each S was randomly assigned to treatment groups, X_1, X_2, or X_3. At least 50 computer numbers were reserved for future enrollees to be included in the randomization so as to ensure replacement of drop outs (Appendix D shows random assignment of S's to groups). Assignments recorded.
3. Each S took Tennessee Self Concept Scale on the computer according to student terminal assignment

schedule which was part of the regular Learning Center Guidance program.

4. Each S took pre-test. Scores recorded.
5. Each S completed program (5 skills to 95%-100% mastery). Scores were printed out on typewriter by computer.
6. For each S, if CAI print out showed that 49 or more problems were correct out of 50, then S proceeded to step 8 below. If print out indicated less than 49 correct, S took remediation program of 50 additional trials).
7. If CA was 49 or above on second group of 50 trials, then S proceeded to step 8 below, if not she repeated step 6 up to six sessions of 50 trials each for a total of 300 trials. The number of trials, time, correct responses and errors were recorded on record sheet provided.
8. Each S took the outside criterion IPI post-test.
9. Ss achieved ratios computed:

$$\frac{\text{[Post minus pretest]}}{\text{100 - pretest}} = \frac{\text{gains}}{\text{gains needed}}$$

10. All data was recorded on record sheet provided.

Statistical Programs

IBM 1130 statistical sub-routines, written in FORTRAN constisted of the following:

(1) Simple statistics, TALLY, BOUND, SUBST, ABSNT, TAB1, TAB2, and SUBMX.

(2) Correlation and CORRE.

(3) Multiple Linear Regression, ABSTRACT, ORDER, and MULTR: Polynomial Regression, ABSTRACT (GDATA, ORDER, MINU, MULTR).

(4) Analysis of Variance, ABSTRACT, AVDAT, AVCAL, and MEANQ.

(5) Analysis of Covariance, MOMEN and TTSTT.

(6) Roots of Polynomial, POLRT.

Programs used to assist in the analysis of the data include: simple statistics, correlation matrices, matrices, analysis of variance, uncorrected sums of squares plus correlation coefficients, corrected sums of squares plus correlation coefficients. Treatment means, estimates of treatment effects, standard errors of means, standard errors of differences and least significant differences were calculated and printed. Tables of estimated residuals were printed. Residuals were plotted for each variable vs self concept. Polynomial equations were computed for each variable vs self concept and plots were printed. These programs tested the significance of differences of the

scores after they have been adjusted by removing that part due to the relation between treatment and scores. Also this method tested the significance of differences between scores after they have been adjusted by removing from them that part due to the relation between self concept and scores.

The means were tested after an adjustment of the sums of squares (Kerlinger, 1964, p. 105).

Measures used were the adjusted total, between groups, and within-groups sums of squares. Variances (mean squares) and the least significant differences were computed from these adjusted measures.

This total design provided for the assumption that measures of personality and achievement usually exist before the experiment starts. In this case personality measures were obtained from all learners in the regular context of the learning center and not directly related to this experiment. The relation between variables was expressed by (1) listing correlation matrices and tables of analysis of variances, (2)graphing the relationships of coefficients of correlation computed to reflect degrees of relation, (3) constructing probability matrix graphs of ordered pairs, and (4) by plotting polynominal equations and residuals. The .05 level of significance was used to reject null hypotheses.

THEORETICAL PERSPECTIVE

Learning Theory

The theoretical basis for the pragmatic system of instruction wherein behavior is explained in terms of its consequences is also the theoretical basis bupon which programmed instruction, individualized instruction and CAI are constructed. The theory is best exemplified in the work of B. F. Skiller (1953) called operant conditioning. He views the phenomena of behavior as basically scientific in character. Specific behavior, as a dependent variable, "can be accounted for in terms of observable and manipulated physical conditions, considered independent variables." He states: (1953, P. 35)

> The external variables of which behavior is a function provide for....functional analysis. We undertake to preditct and control the behavior of an individual organism. This is our 'dependent variable' - the effect for which we are to find the cause. Our 'independent variables' - the causes of behavior - are the external conditions of which behavior is a function.

His theory structure includes the idea that all behavior involves movement, actions, or responses upon the environment as a consequence of some external stimulus. The probability that responses will be repeated is dependent upon the consequences surrounding the specific behavior act. If the consequences are reinforcing, the behavior is more likely to be repeated; the consequences feed back into the organism to change the probability that the behavior which produced them will occur again.

In the presence of specific stimuli the individual learns to act in specific ways in order to be reinforced. Skinner calls such behavior as "behavior under the control of a discriminative stimuli" wherein the reinforcement is the discriminative stimuli.

Basically, his model is built on the stimulus-response association unit of shaping behavior, stamping in behavior and of strengthening habits with the response becoming under the control of the discriminative stimulus of the reinforcement (Thorndike, 1989; Watson, 1925; Hull, 1943, Skinner, 1953).

Thorndike's early 'law of effect' served to explain why certain behavior occurred more often than other behavior in the same situation. In his experiments with cats held captive in cages, he found that behavior leading to escape occurred more often and at an increasing rate of speed with each time that the 'escaped' cat was placed back into the cage, until eventually escape was simple and quick. The escape behavior was 'stamped in'. The reinforcement of escape shaped the behavior of unlatching the cage door. The ability of the cat to operate on the environment to bring about the reinforcement of escape is an observation of Thorndike's 'law of effect' and Skinner's operant conditioning.

For Skinner, the immediate consequences of behavior; the conditions or contingencies of reinforcement are the crux of his Science of Behavior. When human reinforcers

are identified, they can be used to manipulate, control and thus predict any desirable human (or any organism) behavior.

Over time a quantitative measure of such control reflected in the frequency of observable and interpretable responses is called learning. In education when such measures are standardized to produce norms of comparison they are called achievement scores. Very briefly stated: Skinner's theory implies that behavior operates on the environment to generate consequences. Learning is the reassortment of all possible responses in a complex situation. Any phenomena which strengthens or increases the frequency of behavior (operant) is termed a 'reinforcement', when this occurs the process is called 'conditioning' (1953, p. 65). The operant is defined by what ever properties upon which reinforcement is contingent.

The experimental design for operant conditioning consists of arranging for a contingency of reinforcement and exposing a person to it. The frequency of the response is then explained by the events of the contingencies.

Principles applicable to Instruction derived from Operant Theory:

1. When a reinforcement ceases, the responses becomes less and less frequent until it becomes extinct. Resistence to extinction depends upon the conditioning or reinforcement contingencies (Skinner, 1953).

2. Resistance to extinction generated by intermittent reinforcement may be greater than that given for consecutive responses (Skinner and Ferster, 1957).

3. In a programmed learning situation motivation is maintained by the immediate confirmation of each response (Pressey, 1926). Confirmation is a previously conditioned reinforcer.

4. Extremely complex performances may be reached through successive stages in the shaping process (Skinner, 1968).

5. Behavior can be maintained in given stages of strength for long periods of time by varying the schedule of reinforcement (Skinner, 1968, p. 10).

6. In general, a given schedule has an effect upon the rate at which a response is emitted (Skinner, 1968, p. 12).

7. "Paying attention" or perception is reinforced behavior subject to shaping (Skinner, 1968, p. 13).

8. By making each successive step as small as possible, the frequency of reinforcement can be raised to a maximum (rate of response will increase) (Skinner, 1968, p. 21).

9. The most effective control of human learning requires instrumental aid i.e. Each individual is affected by subtle details of contingencies (due to prior conditioning) which are beyond the capacity of the human teacher to arrange.

10. Effective instruction is individualized.

11. Desired terminal behavior to be shaped can be "forced to occur" by using stimuli which evoke it in the first instance, such stimuli, (attention getters), are not the eventual behavior learned. Primes, models, product duplicates, directions, expectancies, feed-back and practice contribute to effective learning (Skinner, 1968, pp. 206-213).

12. Fragments of primes in the form of prompts, fading, vanishing, contribute to learning as they encourage behavior which already exists in some strength (Skinner, 1968, p. 214).

13. The behavior of matching a correct response is reinforcing. ....immediate feedback accelerates learning (Skinner, 1968).

Personality

Recent Theorists such as Freud (1953); Wertheimer (1945); Erickson (1956); Sears (1953); Allport (1936); Cronbach (1963); Guilford (1959); Sheldon (1957); Zeigarnik (1927); Rogers (1959); Snygg and Combs (1959); Kelly (1961), and Smith (1960), have each attempted to explain the organization and structure of personality through systematic empirical methods.

A developmental perspective places them in an order ranginf from Freudian Psychoanalysis, to Gestalt Constructs, to Type Theories, to Phenomenological Life-Space Field theories, and to Introversion-Extroversion and Self theories.

According to Hutt, Isaacson and Blum (1966) none of these embrace a set of explicit assumptions concerning the major dimensions of man's behavior and the interrelationships among these dimensions. However, most do provide insight into behavior and provide basis for significant perdictions.

The theoretical framework of personality most consistent with aspects of this study on "Reinforcement Effects on Learning" is one of the Self. The concept of the Self-concept has received considerable emphasis in recent studies in Psychology, Sociology, Political Science and Anthropology. It is popular on the current scene, and visible in the rationale of Black Power confrontations, counseling practices, and educational guidance practices, religious presentations, mass media advertisements, and foreign policies. It lends structure and

direction toward the design of this dissertation.

The Self according to Carl Rogers (1959) is:

> ....organized, consistent conceptual Gestalt composed of perceptions of the characteristics of the 'I' or 'me' and the perceptions of the relations of the 'I' or 'me' to others and to various aspects of life, together with the values attached to these perceptions.

Roger's theory emphasizes two characteristics of the self; the person's awareness of himself as he sees himself (personal self) and his awareness of his interrelationship's with others (social self). Self concept provides a basic attitudinal orientation toward the world, feelings of the degree of confidence in the ability to rely on oneself. Through experience these feelings, attitudes and values which become perceptual screens for subsequent experiences are learned.

Self theory is an attempt to account for certain phenomena and to conceptualize observations of different phases of behavior (Hall and Lindsey, 1957). The self is a concept within the scope of scientific psychology. William James (1890) defined the self in his Principles of Psychology, to be the sum total of all that a man can call his - body, traits, abilities, possessions, family, friends, enemies, vocation and avocations. He classified and discussed these items into three categories, among the first of which is included the constituents of social self and spiritual self.

Modern psychologists define the term self such that two different sets of meanings are common. One set refers

to the psychological processes which govern behavior and adjustment, the other set refers to the individual's attitudes and feelings about himself. The last set denotes the attitudes, feelings, perceptions and evaluations that a person holds about himself as an object. These comprise what a person thinks of himself.

Carl Rogers has formulated an empirically supported theory of self based on the 'self as object' definition which in turn derived from James' 'constituent' category of the human Empirical Me. His theory is derived from his experiences in his work as a psychotherapist wherein he originated the method of 'client-centered' or non-directive theory (Rogers, 1959).

The theory as summed by Rogers (1959, P. 532) states:

> This theory is basically phenomenological in character and relies heavily upon the concept of self as an explanatory concept. It pictures the end-point of personality development as being a basic congruence between the phenomenal field of experience and the conceptual structure of the self - a situation which if achieved, would represent freedom from internal strain and anxiety, and freedom from potential strain; which would represent the maximum in realistically oriented adaptation; which would mean the establishment of an individualized value system of any other equally well-adjusted member of the human race.

A theory of personality development utilizing the concept as stated by Rogers is dependent upon the subjective variable of (1) the need for positive regard by other people (pp. 74, 82), (2) the need for self regard (p. 87, and (3) need to seek conditions and situations that are of worth (p. 305).

Various aspects of the Self concept can be measured by instruments called self-ratings. Cartwright (1961) found in a study of the effects of psychotherapy on self-consistency, that self ratings improve as individuals improve in their social adjustment. Suinn (1961) found a positive relationship between self acceptance and acceptance of others, whereas Bloch (1962) found that differences between social desirability and adjustment ratings diminished as social adjustment improved. On the other hand Rogers has found a positive relationship between improved self concept and adjustment. These studies indicate relationships between self ratings and adequacy of adjustment.

Environment can affect changes in the self concept as shown in a study by Wessman, Ricks, and Tyle (1960). It has shown improvement in favorable situations (Cartwright, 1961) and deterioration in situations of mortification (Edgerton, 1962).

Basic Assumptions

For the purposes of this study, a summary definition of learning, based principally on "the law of effect" and reinforcement theory which retains its traditional instructional connotations, can be stated: Learning is any more or less permanent modification in an individual's behavior which can be interpreted to fill some need and increase his competence in dealing adequately with his environment.

Some basic assumptions concerning the teaching-learning process provide a philosophic and psychologic frame of reference upon which to build a pedagogy relevant to undereducated adults.

The dignity and worty of the unique individual is a primary tenet. All adults have the capacity for continued intellectual development. Learning occurs only through reinforced responses. The adult must ineract with the environment. The learning experience is to be appropriate to the unique characteristics of the individual adult learner, including: life style, social status, class values, patterns of behavior, maturity, personality, personal history, entering behavior, aptitudes, interests, and self concepts. Learning experiences, which are meaningful and lead to socially desirable results, will be effective. The situation is dominated by purposes and goals set by the learner which arise in the life of the learner but which are not observable to the instructor. Verbal praise statements are positive social reinforcers. Undereducated adults are reinforced by success.

They have little tolerance for failure. The learner needs immediate feedback for each response until criterion is reached, after which intermittent reinforcement is needed to maintain the learner's response. The learner needs practice in the criterion behavior, a model to follow and the opportunity to utilize his learning in the world. Learning experiences are to be selected, organized and sequenced so as to shape terminal behavior from entering behavior in small cumulative interrelated steps. Education will alter the adult's knowledge, beliefs, values, perception of his environment, interpersonal relations and fundamental citizenship. The adult is emotionally attached to old values, therefore changes due to instruction must be gradual. The adult learner needs a supportive climate.

Definition of Terms

Undereducated Adults

By creating the Economic Opportunity Act of 1964 the Adult Education of 1966, and its revisions of 1969, Congress established a program to help provide for schooling up to the eighth grade level for those adults sixteen years of age and older who are illiterate and functionally illiterate.

In this study the term undereducated adult will refer to any adult sixteen years of age or more who has less than an eighth grade education.

Personality

Personality is a hypothetical construct of organized consistent structures and processes within any individual that dispose him to act in certain ways. Included in these structures are those of self-concept and social adjustment (DeCecco, 1969, pp. 66-67). The self-concept refers to an individual's response to his social and physical environment according to his perception of the environment. His behavior is directed toward maintaining and enhancing this perception. An interpretation of responses, or personality, is either in terms of secondary of psychogenic needs or in terms of the psychology of learning, i.e., drive, reinforcement, stimulus and response.

In this study personality will deal with the structure, self concept. Self-concept will refer to the P scores as totaled from nine separate scores of the Tennessee Self Concept Scale (see Appendix A for sample profile).

Reinforcement

The Skinnerian approach to shaping behavior assumes reinforcement to include any phenomena that increases the probability that a response will be repeated upon presentation of a given stimulus. This concept of reinforcement accounts for the maintenance and strength of behavior (Skinner, 1968, pp. 3-8). Within this framework the response is called an operant. The quality and interpretation of the consequences determine the quality of the reinforcement. When an operant

is followed by the presentation of a reinforcement that strengthens it, the reinforcement is termed "positive". When the operant is followed by the termination of some stimulus situation, such consequences are termed, "negative reinforcement". The reinforcement always follows the operant (Smith and Moore, 1966).

In this study positive reinforcement refers to any praise statement directed to the student as a consequence of his response. Simple feedback giving the student knowledge of results was given for all responses in the form of one word of confirmation or by the automatic progression of the lesson frame on the computer. The student always knew immediately whether he was right or wrong. Confirmation words were either "yes" or "no" or "correct" or "incorrect". In addition, some students received positive reinforcement in the form of praise statements. Praise statements for correct responses were selected at random from a list of five. (The five statements primarily suggested by learners drawn from the sample population include: "Good, you are doing nicely", "Keep up the good work", "You have chosen the right answer", "Good thinker", and "Good work".) Praise statements for incorrect responses were selected at random from a similarly suggested list of five: "Wrong, but better luck next time", "Wrong, but keep trying", "No, but you're almost right, try harder", "No, but you're getting close, study it again", and "Wrong, you've been doing pretty good, think again."

Reinforcement Schedule

The frequency of reinforcement can be presented on various schedules; interval, ratio and mixed. Interval is determined by the passage of time since the last reinforcement. Ratio is the rate of reinforcement to responses. Mixed includes a combination of interval and ratio. Schedules can be fixed, varied, or random (Lumsdaine, 1960).

In this study three schedules were used to test the effect of the independent variable. (1) One group received zero percent positive reinforcement. They received feedback as to right and wrong answers but received no praise statements. (2) One group received 100 percent fixed ratio reinforcement. Each student received reinforcement in the form of pra-se statements each time that he made a response. (3) One group received 30 percent variable ratio reinforcement on a random basis. The student received reinforcement for responses ranging from the first response to the tenth after each previous reinforcement but averaging three reinforcements for each of ten responses. The first reinforcement occurred at random from the first five possible responses.

Achievement

Achievement is a measurement of the level of competence in some skill area that a learner has attained according to some outside standard. The testing instrument is not imbedded in the lesson. Generally, according to

Torgerson, (1954, pp. 10-17, it is a comparative score matched against a norm or standard. The concept refers to either a learner's level compared to a group norm or it can also refer to a specific individual increase in scores measured over time using the same test compared to an initial starting point.

In this study the latter definition was used: Achievement was the change in the learner's ability to solve simple fractions. It represented the amount of learning that took place from the time the student started instruction until he finished 50 problems in a series of 5 skills in the fractions areas at level D of the IPI program. (See appendix B) The testing instrument was the IPI pre and post tests for fractions at level D. Achievement as a dependent variable was interpreted as more than the difference between pre and post test scores. In order that achievement scores reflect learning as a function of learner needs, and to control for individual differences in the assessment of amount of learning, an index was needed to measure the portion learned of the total to be learned.

Therefore, in this study, achievement was computed as the percentage ratio of the pre-post test gain to gain needed.

$$\text{Ach.} = \frac{\text{Post-Pretest gains}}{\text{100-Pretest score}} \% \text{ or } = \frac{\text{gains}}{\text{gains needed}}$$

All learners were initially assigned to a math lesson for which their placement diagnostic test scores indicated a

0 - 20 percent level of mastery on the next higher level, i.e. 0 - 20 percent score on any one unit indicated that the student did not have the minimum skills needed to place in this unit and should be placed in the next lower unit.

Accuracy

Accuracy refers to the acceptable correct matching of the student responses with those stored in the computer printed out as the sum of the correct answers (ca).

Rate of Learning

In this study the total time measured and recorded in tenths of seconds from entering ability to the criterion of 100 percent correct performance on any IPI skill was recorded. The ratio of total time to total gains is considered rate of learning. The computer recorded time from "sign-on" to "sign-off" for each student for the total of all problems.

Computer Assisted Instruction

Computer Assisted Instruction (CAI) is the use of a remote time sharing computer system of terminals in the instructional process as an instrument for assisting the teacher in providing the opportunity for individualized instruction. Student attainment of specific learning objectives is assured through basic CAI strategies which include: tutorial dialogue, drill and practice, simulation, problem solving, testing, free response. (See Appendix E for detailed graph of system).

The IBM 1500 Instructional System has the capability of operating simultaneously 32 student terminals. Each

terminal provides student computer interaction through the devices of a Cathode Ray Tude Instructional Display Screen, light pen, image projector, typewriter and audio unit.

For the purpose of this study, student attainment of specific math skills objectives was gained through the IBM 1500 System using the strategy of instructional practice with the light pen and keyboard.

Review of Related Literature

Because formal education is the social institution charged to shape social behavior for citizenship, its effectiveness is a matter of concern. The major components of the educational system are of special concern to an educator. The learner, conditions of learning and outcomes must be focused upon in attempting to evaluate educational effectiveness.

Traditionally, dialogue about the effectiveness of the phenomena of education has focused on only the philosophic and pedagogical issues underlying assumptions held by civil authorities responsible for education's direction. But philosophic and spiritual approaches alone do not lend themselves to scientific solutions to human problems. Research into the effectiveness of education is needed that can contribute knowledge to theory. Educators and psychologists such as Sax, Kelley and Pierce would propose that such study requires that the

variables controlling or influencing components of the system be observed, identified and analyzed by a systematic pragmatic method so as to expose relationships existing between the variables (1968, 1947 and 1942).

Within the past decade much literature has accumulated about the educational process. In this review emphasis will be given to theories of behavior, learning and reinforcement which serve as bases for instructional technology, programmed learning and computer assisted instruction.

The review will focus on studies which relate reinforcement to learner personality and learner performance.

The general plan of the review will observe the following topical sequence:

I. Educational and Teaching Theory
   - A. Historical Teaching Models
   - B. Modern Teaching Models

II. Behavioral Science Theory
   - A. Behavior and Personality Theory
   - B. Learning Theory
   - C. Reinforcement Theory

III. Educational Technology
   - A. Programmed Instruction
   - B. Teaching Machines
   - C. Computer Assisted Instruction

IV. Summary

SURVEY OF RELATED LITERATURE

Teaching Theory and Models

DeCecco (1968, p. 9) has stated that a philosophy of education deals with the goals and values of an educational system. Educational philosophy influences theories of teaching and determines the ends toward which schools work, or as Gage (1963, p. 133) has said it determines:

> How teachers behave, why they behave as they do, and with what effects.

Some useful models of teaching which prescribe the teaching process and show promise of eventual contribution to a scientifically based theory can be identified from the literature.

Of the enduring traditional teaching concepts, three are still dominant in current practice; the Socratic model, the Jesuit model, and the personal-development model.

DeCecco points out that the Socratic method was mainly concerned with development in the skill of inquiry (p. 22):

> Socrates was less concerned with the acquisition of particular facts and concepts than with the development of skill in asking questions which led to the "truth"....The teacher's role consisted mainly of asking questions: the student's of organizing his past experiences to answer the questions....The method was indecisive....The moment of truth arrived when the student grasped the proper relationship....

According to Broudy (1963, p. 22) the Jesuit model as exemplified in the Ratio Studiorum, stressed the acquisition of good skill performance in speaking, writing, reasoning and critizing by practicing, reviewing and testing.

> The Jesuits built performance assessment intimately into their system. The standard of achievement was mastery of the material and its retention. The teacher or fellow students under the direction of the teacher regularly checked assignments and returned them to the student. The frequent reviews in themselves uncovered what was learned and how well.

The personal-development model based on the early works of Rousseau, Froebel and Pestilozzi, is today illustrated by the rather flexible model of Donald Snygg and Arthur Combs (1949, 1959) which stresses personal adjustment, individual behavior and differences, and self-enhancement. The student discovers his own strengths, develops his own personality and becomes able to adequately relate to others; he develops a positive self concept such that he is able to adjust to the changing social world. The educational goals of this model as stated by Snygg and Combs (1959, p. 138):

> For the good of our society and its members it is better to wish for intelligent behavior than for good penmanship or the ability to diagram a declarative sentence or any of the other limited objectives which may or may not be a valuable means of need satisfaction in the future.

The personal adjustment model stresses the psychological principles of self esteem, success, readiness, individualized instruction, transfer, interest, and teacher-pupil interaction.

Educators such as Stolurow (1965), Glaser (1962, 1965), Carroll (1962, 1963, 1965), Flanders (1960, 1964), Popham (1967), and Skinner (1968) have each contributed to teaching theory by developing more modern models of teaching.

According to DeCecco (1968, p. 19) the models of Glaser (1962, p. 6), Stolurow, Carroll, and Flanders are similar to the extent that they each include four common components: (1) Instructional objectives, (2) Entering behavior, (3) Instructional procedures and, (4) Performance assessment.

These four models indicate that in the teaching process a broad range of teacher decisions and student practice is stressed rather than student-teacher personal interaction. The learning experience is planned to provide for interaction between the student and the subject matter. The competence of the teacher is utilized to determine the consequences of the interaction.

The model as designed by Popham (1967) stresses a sequence of teacher behaviors which he calls instructional decisions. This includes (ibid, p. 15):

> The device employs four deceptively simple components. First, objectives of instruction are specified in terms of post-instruction learner behavior. Second, the student's present competence is determined with respect to these instructional objectives. Third, activities for the teacher and student are selected in order to achieve the stated objectives. Fourth, the learner's attainment of the objectives is evaluated.

The model as designed by Skinner (1968) is more simple, explicit and precise than any of the other models. Based on an empirical ontology dating from Pavlov, Thorndike, Hull, and Estes, the current model, Skinner states (1968, p. 4-5) can be utilized to shape behavior....teaching is simply the arrangement of appropriate contingencies of reinforcement. Three variables compose the so-called contingencies: (1) An

occasion upon which behavior occurs, (2) The behavior itself, (3) The consequences of the behavior....Teaching is the expediting of behavior.

With the exception of Snygg and Combs' all of the described modern teaching models bear certain resemblances. A synthesis of their common elements would produce the following composite model:

1. Identify and order instructional objectives
2. Assess entering behavior
3. Present instructional activity
4. Allow for practice
5. Test for desired performance
6. Reinforce desired performance

Each step in the teaching process is based on related principles of learning derived from Behavioral Science which collectively provide a theoretical construct to describe and explain the conditions under which learning can be expected to occur. The model is supported by leaders of innovative educational technology. Tyler (1950) and Popham (1965) have identified the principles of "appropriate practice" and "knowledge of results." Gagne (1965), Mager (1962), Popham (1965) and Tyler (1964) have stressed the importance of behaviorally stated objectives in the teaching model. In a recent study on the effectiveness of behavioral objectives, Blaney and McKie (1969) found that among learners attending a conference, those who were given behaviorally stated

objectives did significantly better than those given a general orientation to the program conference as is the usual conference treatment.

Behavioral Science

The bulk of research directed toward discovering relationships between personality attributes and learning outcomes has been carried on with samples of children in school situations, in clinic, or with mentally retardees. Only recently has concerted effort focused on the undereducated adult as a potential learner, and only now are his attributes being explored. Though child and youth oriented, some research is germane to the study of variables active in programmed instruction regardless of learner age.

McDonald (1962) in a study of the relationship of socio-economic status and, (1) an objective measure of motivation, (2) prediction of academic achievement for a Michigan high school sample of statistically defined, over-achievers, under-achievers, normals and general population of 11th graders of each sex, found that:

> Over-achievers come from high socio-economic homes while under achievers are found in no particular socio-economic status.

In a recent study by Doty and Doty (1964) data results supported the hypothesis:

> Effectiveness of programmed instruction varies as a function of student personality variables.

> Students who learned most from the programmed material (i.e., those with highest scores on the test over the programmed unit) were characterized by relatively low social needs....the programmed approach....is essentially a solitary one in which each student proceeds independently.

The suggestion here is that social need is an important variable in the programmed learning situation.

Feelings of anxiety, as a variable has been noted in numerous research studies, in relation to learning style. Most data suggest a significant relationship to achievement. Research in the CAI mode is scarce due to the recent entrance of the media to the classroom situation, Porter (1957) has noted that:

> One benefit of automated instruction seems to stem from the fact that some learners become less anxious about their performance on the subject matter after they have used a teaching device for some time.

An implication here relating to self concept suggests that learners lacking self confidence and sense a lack of control in a new situation need special orientation and support when first introduced to the terminal.

In support of the premise that self concept, environmental and cultural conditions, and learning style are related, findings by Frost and Hawk (1966) have indicated that intellectual characteristics as well as personality attributes accompany cultural deprivation. Included are these:

> Fear of being ridiculed, feelings of alienation, inadequacy, being misunderstood, and negative self-image as a problem solver. ....poor performance on speeded or timed tests.

Erickson (1967) in a study of "Programmed Learning and Personality Styles", found no significant differences between the learning rates of students using programmed materials and those using conventional procedures. Students accustomed to programmed materials are less rigid in their perceptions. The differences between the groups on personality measures were not pronounced. Erickson concluded that future studies should compare individual characteristics with success or failure in programmed learning.

Lubin (1968) in a study of reinforcement schedules, Scholastic Aptitude, Autonomy Need, and Achievement in a programmed course, found that the groups receiving no reinforcement and variable-ratio reinforcement scored significantly higher on the criterion test than the group receiving continuous reinforcement. The Autonomy-need group, with the low autonomy need scores scored significantly higher than the group with the high-autonomy need scores. The above-average scholastic aptitude group scored significantly higher than the below-average aptitude group. The results of the variable-ratio schedule of reinforcement agrees with the results of Skinner and others.

Campean (1968) in a study of test anxiety and feedback in programmed instruction found that learning can be improved by adjusting programming procedures to adapt to individual differences in test-anxiety level. This study suggests that programmed instructional materials should be designed to use

the types of reinforcement, cues, feedback, prompting, etc., that produce the least anxiety in the individual student.

Lezotte, Lawrence, and Bondy, (1967) in a study of interest patterns of successful and non-successful male collegiate technical students found that interest measures do differentiate between successful and non-successful technical learners. Successful are "thing" oriented, unsuccessful are "people" oriented. The interest patterns of the males in the study supports Roe's (1957) hypothesis of a person-non-person orientation; a self concept hypothesis. The results also agree with the "things versus people" bipolar factor identified by Thurstone (1931) and supported by Strong (1943).

Findings by Holland (1959) indicate that:

> Behavior is learned when it is emitted and reinforced. Not only is reinforcement needed for learning, a high density of correct items is necessary because material which generates errors is punishing.

The implication this relationship suggests is that the totality of learning behavior i.e., going to school, being in attendance, participating in school work, studying and wanting to learn are the behaviors that will become extinct due to non reinforcement in the failure or error consequences. Adult learners must be provided errorless learning experiences as in PI and CAI to develop appropriate behavior patterns for learning.

In this regard Azrin (1956) found in laboratory experiments that punishment lowers the rate of the punished

behavior.

In a study directly related to this research, tying personality characteristics of the learner to his performance when different conditions of social reinforcement are employed, Stolurow (1967) discovered that when qualitative statements like "excellent", "you are coming along fine", "right on the button", etc., are employed to different groups all of whom studied the same program logic, results were variable. In the study, four groups of students received different reinforcement: Group 1 had all responses evaluated, group 2 had only correct responses evaluated, group 3 had only incorrect responses evaluated, and group 4 received only knowledge of results.

Data analysis showed: ....that each of the four experimental conditions of social reinforcement was most suited to a different personality group.... Three personality characteristics, aggression, deference and introspection, were found to be important in relation to performance under the four different conditions of social reinforcement.... The findings on this study and a later replication indicate that negative evaluations are more important than positive, and also that performance can be altered by the way in which social reinforcement is used during the learning situation.

There appears to be a growing body of research on personality and feedback.

In studies such as Doty and Doty (1964) (mentioned

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above) there was some evidence to indicate that learners with social needs, such as recognition and approval perform less well in programmed learning than others with less social need. Dick and Sequin, (1964) attributed this finding to the fact of social isolation. There are others, (Austwick and Robson, 1964), (Dick, 1964),(Robson, 1967), who have attempted to overcome the social isolation of the learner in programmed learning situations by pairing students on the basis of some measure related to speed, (test scores) personality (dominance as opposed to submissiveness) and dissimilarity. Results suggest an increase in the time required for completion of the program, also decreases or no differences. At any rate these studies indicate inconclusive evidence regarding pairing as a method to increase rate while providing for social needs. Different personalities require different self-pacing schedules. A recent finding (Robson, 1966) indicated that where learners were paired on the basis of previous established rates in a regular situation, and where charts provided a visible progress report for all to see, rates increased as "a negative correlation between students recent marks obtained in their relevant school examination and the times required for program completion." Here charts focus attention on learner's own performances in relation to what others are doing and give guides as to expectations.

Another study contributing insight into personality

attributes active in learning was conducted by Davis and Leith (1966) where they evaluated effects on learning and attitude by manipulating (1) subjects environment, 2 good and 2 poor schools, (2) social reinforcement, praise, blame or nothing, (3) teacher interaction with programmed text, teacher administered reinforcement vs text administered reinforcement, and (4) personality variables, six different tests, questionnaires and inventories.

The following significant findings were noted:

> ....difference at 0.01 level between the means of the positive reinforcement and negative reinforcement group.
> ....difference at 0.05 level between means of positive reinforcement group and neutral reinforcement group.
> ....no difference between negative reinforcement and neutral reinforcement.
> ....test scores/extroversion: r=0.182 (0.05 level).
> ....test scores/1.0 scores r=0.495 (0.001 level)
> ....extroversion/anxiety chi-sq.= 9.98 (0.025 level)

On effects of neutral reinforcement Davis and Leith are in agreement with Holland (1959) and Perin (1943), they state:

> Confirmation of response is known to be secondary rather than primary reinforcement, i.e., confirmation is not reinforcing in itself, but must be previously conditioned as a reinforcer. If however, the necessary conditioning has not taken place the learning dependent on this conditional reinforcer is likely to be greatly reduced.

and further with a learner:

> who is culturally deprived or completely lacking in motivation the problem of secondary reinforcers may well become acute.

on this point Gagne, and Bolles (1959) revealed:

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> Confirming the correctness of a learner's response to problems may be expected to be reinforcing only if the learner's motivation is intrinsic to the task being learned.

In another study Holland (1959) revealed:

> Instructional programs modified to fit the student will promote learning .... also, the time required to complete the program was reduced.

Research on CAI learning has just begun to receive support from vendors, agencies and the federal government. Results are now beginning to appear in journal reports, conference proceedings, and ERIC publications. Reinforcement schedules, knowledge of results contingencies and reward strategies are becoming popular topics. Lane (1963) reports that Meyer (1960) studied: (a) immediate versus delayed knowledge of results, and (b) correction procedures. He found (a) absolute scores were higher (.06 level) for groups who received answers than for groups who did not (b) gain scores (pretest-post-test) scores were higher ($p = .03$) for groups who received a confirmation of results over those who did not.[1]

Krumboltz and Weisman (1962) studied the effect of intermittent confirmation. Their design included six variations of confirming answers:

---

[1]Meyer, Susan R. Report on the initial test of a junior high school vocabulary program. In A. A. Lumsdaine & R. Glaser (Eds.) Teaching machines and programmed learning: a source book. Washington: National Educ. Ass., 1960, pp. 229-246.

1. Continuous confirmation: Answers for every response.

2. Fixed-ratio 67 per cent: Answers to every third response omitted.

3. Variable-ratio 67 per cent: on the average only two-thirds of the responses at irregular intervals received confirmation.

4. Fixed ratio 33 per cent: Confirmation every third response.

5. Variable-ratio 33 per cent: On the average one-third of the responses at irregular intervals were confirmed.

6. No confirmation.

Two findings were (a) a significant negative relationship between the amount of confirmation and the number of errors, and (b) no significant difference among the schedules of reinforcement on the criterion test.

E. M. Quinn (1967) reports in a study of children in a CAI math program that a significant positive relationship exists between the amount of practice sessions (actual clock time) and performance gains.[1] All responses received confirmation.

Experimental designs are needed so that the time variable can be controlled in order to determine its influence on individual differences and achievement outcomes when reinforcement is varied in CAI.

---

[1]E. M. Quinn. 1967. Computer Assisted Instruction Arithmetic Drill and Practice Exercises: Report of Field Test. IBM Watson Research Center, Yorktown Height, New York.

RESULTS

Preliminary to the research investigation, three tests were conducted concerning the self concept construct, the CAI terminal equipment, and the research sample. Tests were used to estimate (1) the reliability of the Tennessee Self Concept Inventory to measure self concept when the reading method of paper-and-pencil presentation of items is replaced by audio tape recorded presentation, (2) the reliability of the inventory when the tape recorder audio is replaced by CAI terminal audio, and (3) the homogeneity of the sampling population to the normal population.

A preliminary analysis of correlation between a randomly selected sample of self concept scores from the publisher's paper-and-pencil form and a tape recorded version (identical to the publisher's form) was used to test the validity of the content versus visual or audio mode of presentation; $r = .69$ was obtained. A correlation coefficient was then computed between scores on the tape recorded form and scores on an identical version adapted to the computer terminal using the audio facility. The purpose of this correlation was to test the validity of audio content versus technical equipment. Here $r = .79$.

Analysis of correlation indicated that CAI scores systematically varied from paper-and-pencil scores by - 38.71 points with error of $\pm$ 9.81. CAI scores were then adjusted

to comparable normal scores by the addition of the correction term (+38.71). This was done in order to run an introductory comparison of the preliminary sample mean to the population mean and thus estimate the homogeneity of the research sample self concept mean to the population self concept mean. The adjusted sample mean was found to be 1.01 sd. from the population mean ($Z_{.002}$=-6.9, one-tailed test). It was found to lie at the .5 percentile in the population distribution. The sample had a lower P score than did the population on which the test was normed. The sample P scores are significantly different from the population P scores at the .01 level of significance (see Table 1).

Self Concept and Dependent Variables

An introductory analysis of correlation program was executed for the total sample between self concept scores and the criterion variables: gains, percentage achievement, total trials, total time, total errors and latency rate. Simple statistics of these variables are presented in Table 2. As shown in Table 1 the research sample self concept scores did not differ from the preliminary sample scores ($Z_{.51}$=-.025). A correlation coefficients matrix as shown in Table 3 indicates a coefficient of .76885 between Total Trials and Total Errors, also a coefficient of .60461 between Total Time and Total Trials. A functional relationship between these variables was inherent in the research plan; that is, a student who made more than one error on trial K was

Table 1. Standard deviations and adjusted P score means

	N	Mean	r	Adj. Mean	Standard Dev.	Est. Error
Pre-Sample Paper-Pencil	15	320.37	.79	320.37	25.42	6.6
Pre-Sample CAI	14	275.64		314.35*	18.33	4.1
Correction Coefficient	14	38.71			19.09	5.1
Group I	16	276.75		315.46	11.59	2.89
Group II	16	271.93		310.64	13.79	3.44
Group III	16	278.43		317.14	18.69	4.67
Grand Mean		275.71		314.41**	14.92	2.4
Norm Group	625	345.57		345.57	30.70	1.23

* $Z_{.002}$ =-2.8 1.96, p=.005 research sample significantly different from population

**$Z_{.51}$ =-.025 p=.51 research sample no different from pre-sample

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Table 2. Simple statistics for analysis of covariance between self concept and dependent variables

VARIABLE	SUM	MEAN	UNCOR SS	COR SS	VARIANCE	ST. DEV.
Self Concept	13234.00000	275.70833	3659198.00292	10473.91602	222.84927	14.92813
Gains	977.99999	20.37199	31954.59994	12027.85002	255.91170	15.99724
Achievement	3823.50000	79.65625	324623.25036	20057.57814	426.75698	20.65809
Total Trials	6200.00000	129.16666	985000.00073	184166.66668	3918.43971	62.59744
Total Time	4265.19998	88.85833	533395.29736	154396.73791	3285.03697	57.31524
Total Errors	535.00000	11.14583	13487.00000	7523.97916	160.08466	12.65245
Rate	13.9228	.2901	6.9365	2.8968	.0616	.2490

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Table 3. Matrix of correlation coefficients of total research variables (self concept, gains, achievement, trials, time and errors)

	SELF CONCEPT	GAINS	ACHIEVEMENT	TOTAL TRIALS	TOTAL TIME	TOTAL ERRORS
Self Concept	1.00000	0.01832	-0.27033	0.42255	0.25937	0.48010
Gains	0.01832	1.00000	0.11115	0.41803	0.06525	0.22534
Achievement	-0.27033	0.11115	1.00000	-0.27960	-0.18860	-0.42248
Total Trials	0.42255	0.41803	-0.27960	1.00000	0.60461	0.76685
Total Time	0.25937	0.06525	-0.18860	0.60461	1.00000	0.46980
Total Errors	0.48010	0.22534	-0.42248	0.76685	0.46980	1.00000

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automatically programmed to an additional trial K which naturally meant an increase in total time to complete the program. A significant relationship was indicated between self concept and total trials within the total sample.

Plotted polynomial equations (Y = a +bx) indicate regression coefficients obtained were small and negative. A summary of polynomial equations is shown in Table 4. Plots are shown in Figures 4-8.

Matrices to support the polynomional equations were derived from Tables 2 and 3.

Analyses of variance and plotted residuals for the total sample on each dependent variable are shown in Tables 20-24 and Figures 24-28 respectively. Here too, residual lines are flat with small slope indicating small within-total sample relationships between self concept scores and response variables.

Self Concept and Dependent Variables Within Treatment Groups

A comprehensive analysis of correlation and multiple regression program was then executed for each treatment group between self concept scores and learner performances. Plotted residuals which indicate the degree of relationship between variables are shown in Figures 9-23. Analyses of variance appear in Tables 5-19.

Simple statistics for the within-group variation on these dependent variables appear in Tables 25-27. Correlation matrices are shown in Tables 28-30. Most coefficients are small within Groups I and II. Significant relationships between self concept and other research variables were indicated for Group III. Correlations from Table 38 indicated:

(1) Group I, self concept and trials, r = .46;
gains and errors, r = .67
trials and time, r = .52
trials and errors, r = .76
time and errors, r = .42

(2) Group II, achievement and errors, r = -.57
achievement and time, r = -.45
trials and time, r = .79
trials and errors, r = .65
time and errors, r = .82

(3) Group III, self concept and achievement, r = -.50
self concept and trials, r = .51
self concept and time, r = .51
self concept and errors, r = .64
gains and trials, r = .53
achievement and trials, r = -.49
achievement and errors, r = -.55
trials and time, r = .47
trials and errors, r = .89

Figures 24-30 and Tables 37-38 display between group variations on the several criterion performance measures and point up the directions that differences assumed for Ss in this study. Group II needed more trials, required more time and made more gains than Group I or Group III.

The hypothesis stated that learner performances on achievement, error rate, and rate of learning would not vary systematically when reinforcement schedules were varied. The hypothesis is accepted for achievement, total errors, total time, total trials and rate of learning.

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The exception here is gains. The hypothesis is accepted for differences between Group I (0%) and Group III (100% reinforcement schedule) on actual gains, (a Type II error is risked here by concluding that the groups do not differ, when some other statement about the groups might actually be true) but rejected for differences between 0% and 30% random schedules. The main effect of knowledge of results plus praise statements on a 30% schedule is significantly superior to treatment of knowledge of results only. Group II (30% random schedule) differed significantly from Group I on the mean number of actual gains made from pre test to post-test scores for the unit on fractions of the IPI Math program. The risk here is a Type I error: Rejecting the hypothesis when it is true. The probability of a Type I error is .05.

Self Concept and Treatment

The hypothesis stated that there are no significant relationships between self concept P scores and effects of positive reinforcement schedules on learner performances for Ss in a CAI math program.

Using Fisher's Z distribution to test the differences between groups on self concept and performance correlation coefficients, the following significant probabilities are indicated:

(1) gains r, Group I and Group II, $p = .02$
r, Group I and Group III, $p = .02$

(2) achievement r, Group I and Group II, $p = .004$
r, Group I and Group III, $p = .001$
r, Group II and Group III, $p = .001$

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(3) Trials, r, Group I and Group II, p = .01
r, Group II and Group III, p = .001

(4) Time, r, Group I and Group III, p = .001
r, Group II and Group III, p = .001

(5) Errors, r, Group I and Group III, p = .001
r, Group II and Group III, p = .001

The hypothesis is rejected as significant relationships between self concept, reinforcement and learner performances are indicated.

Treatment vs Performance

Analyses of variances between groups were computed using (1) pre-post test gains, (2) total time in minutes and tenths of minutes, (3) total errors over K trials, (4) rate of learning (gains/total time), (5) achievement (gain/gain needed) percentage, and (6) total trials as the dependent variables. A summary of the analyses is shown in Tables 31-36. Tables 37 and 38 summarize the means and estimates of treatment effects for each group of Ss on six performance criterion measures. A complete summary of research analysis is found in Appendix F.

The test of the effect of reinforcement on gains was significant at the .05 level of confidence between Group I and Group II (LSD = 9.2896). Group II made significantly more gains than Group I. This group received praise statements 30% of the time on a random schedule in addition to knowledge of results 100% of the time. Other data of the observed treatment effects indicated differences between group means to be no greater than chance. ($t < 2.14$)

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Table 4. Summary of polynomial equations for total sample

Sample	Criterion	Prediction
TOTAL GROUPS	RESPONSE	EQUATION
1, 2, 3	ACHIEVEMENT	Y = 182.799-.3741X*
1, 2, 3	GAINS	Y = 14.9616-.01963X
1, 2, 3	TOTAL TRIALS	Y = 359.350 +1.77186X
1, 2, 3	TOTAL TIME	Y = 185.7102 +.09958X
1, 2, 3	TOTAL ERRORS	Y = 101.045 + .40691X

*Y= Criterion Performance

X= Self Concept

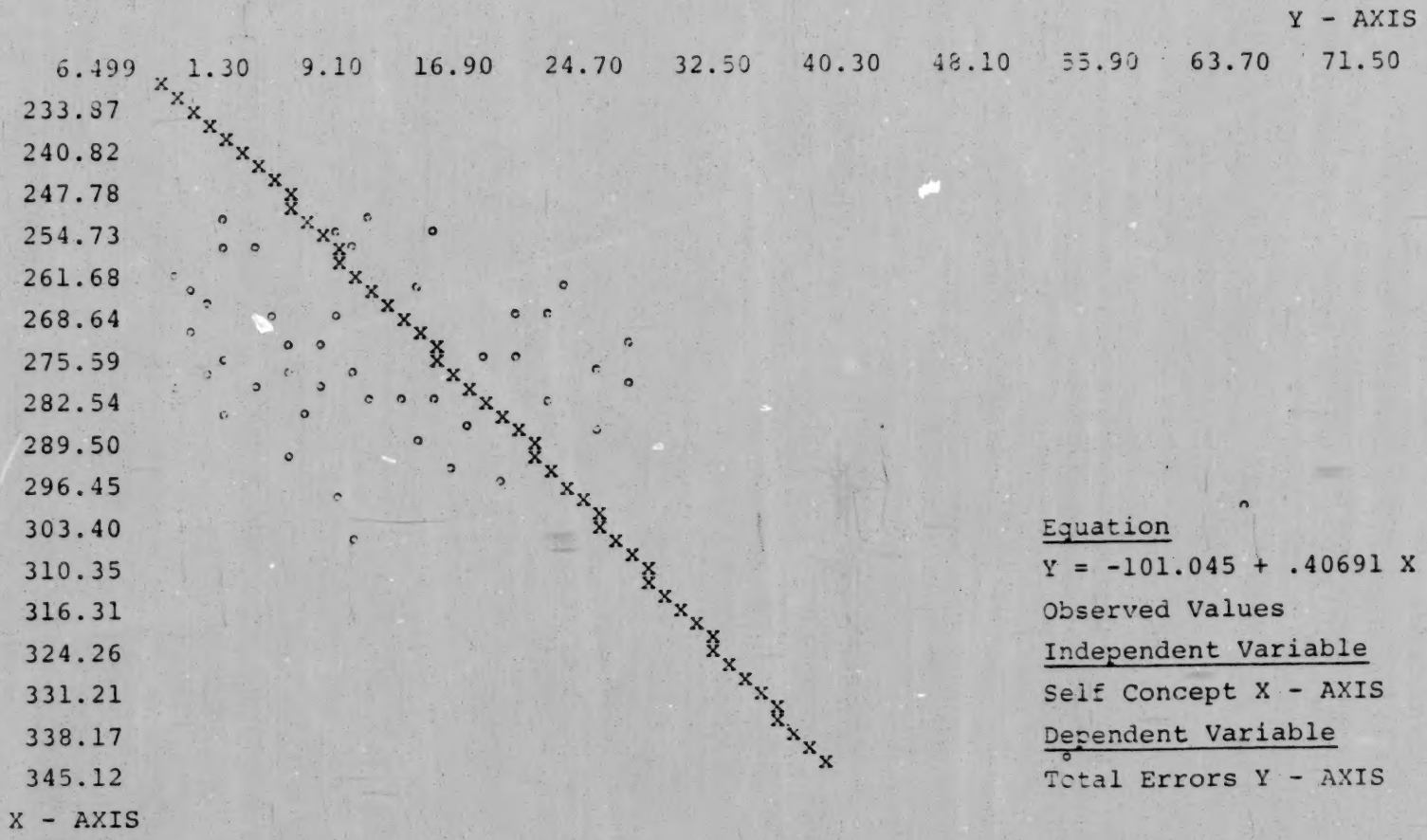

Figure 4. Plotted polynomial equation, self concept, response total errors, groups I, II, and III

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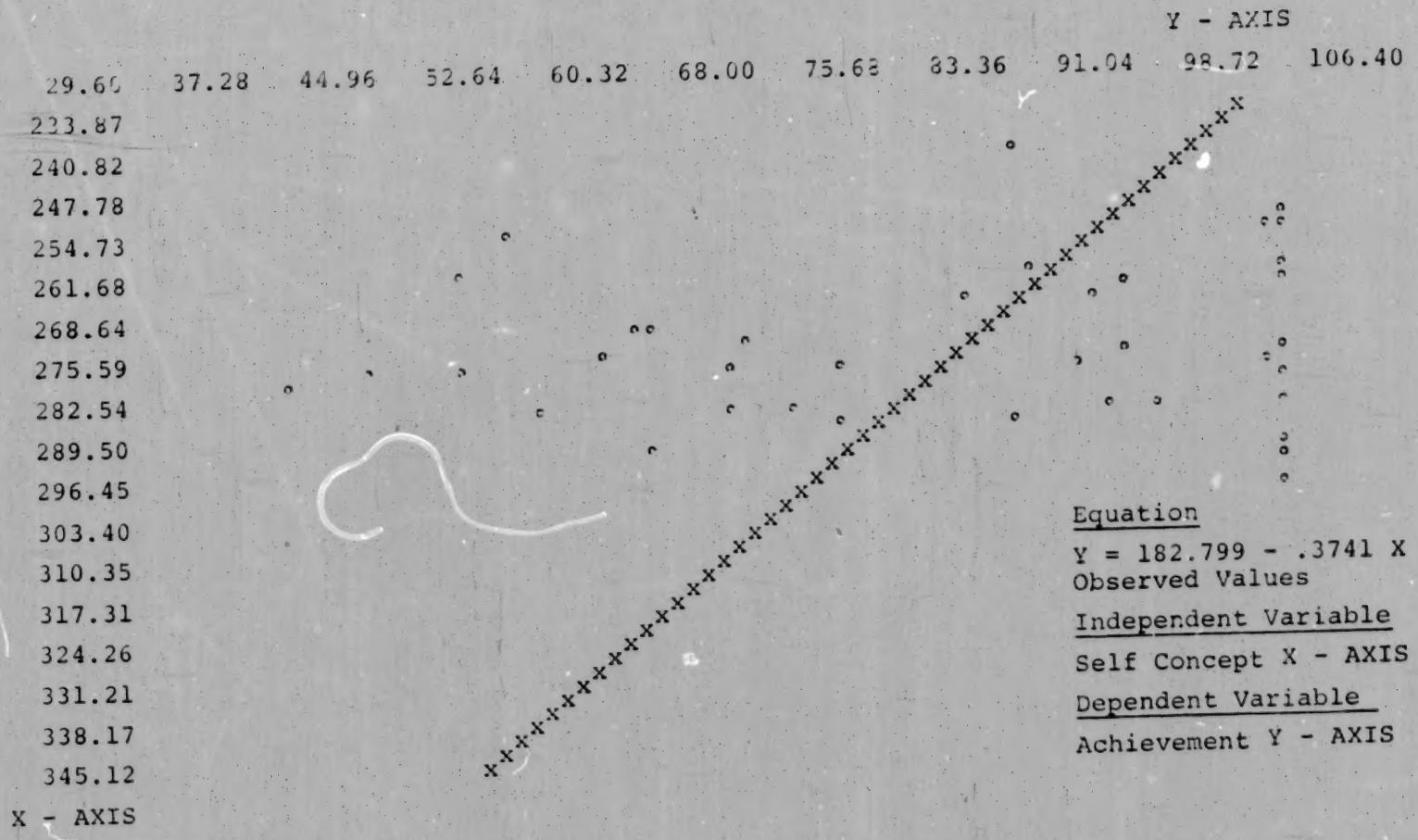

Figure 5. Plotted polynomial equation, self concept, response achievement, groups I, II, and III

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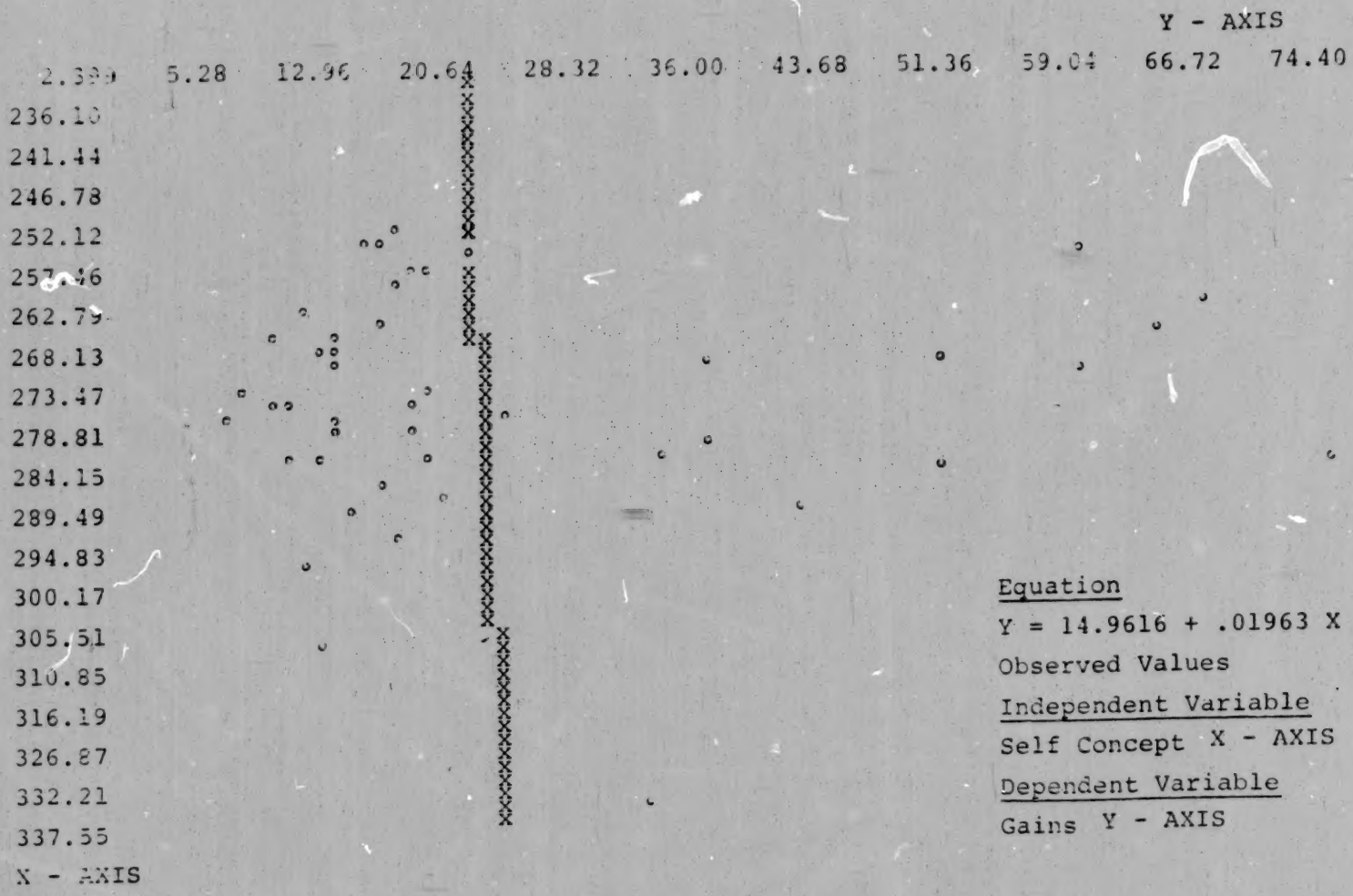

Figure 6. Plotted polynomial equation, self concept, response gains, groups I, II, and III

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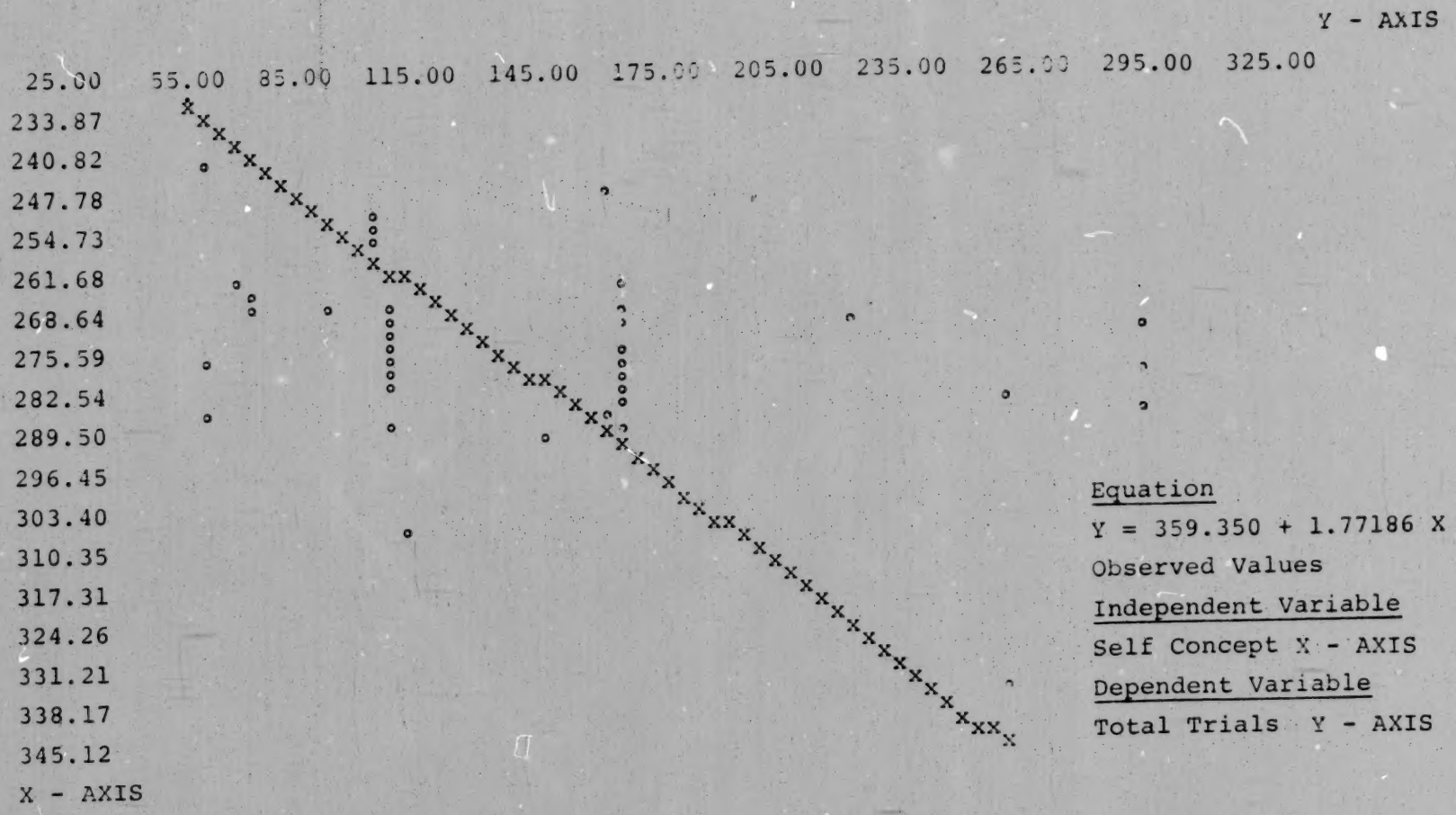

Figure 7. Plotted polynomial equation, self concept, response total trials, groups I, II, and III

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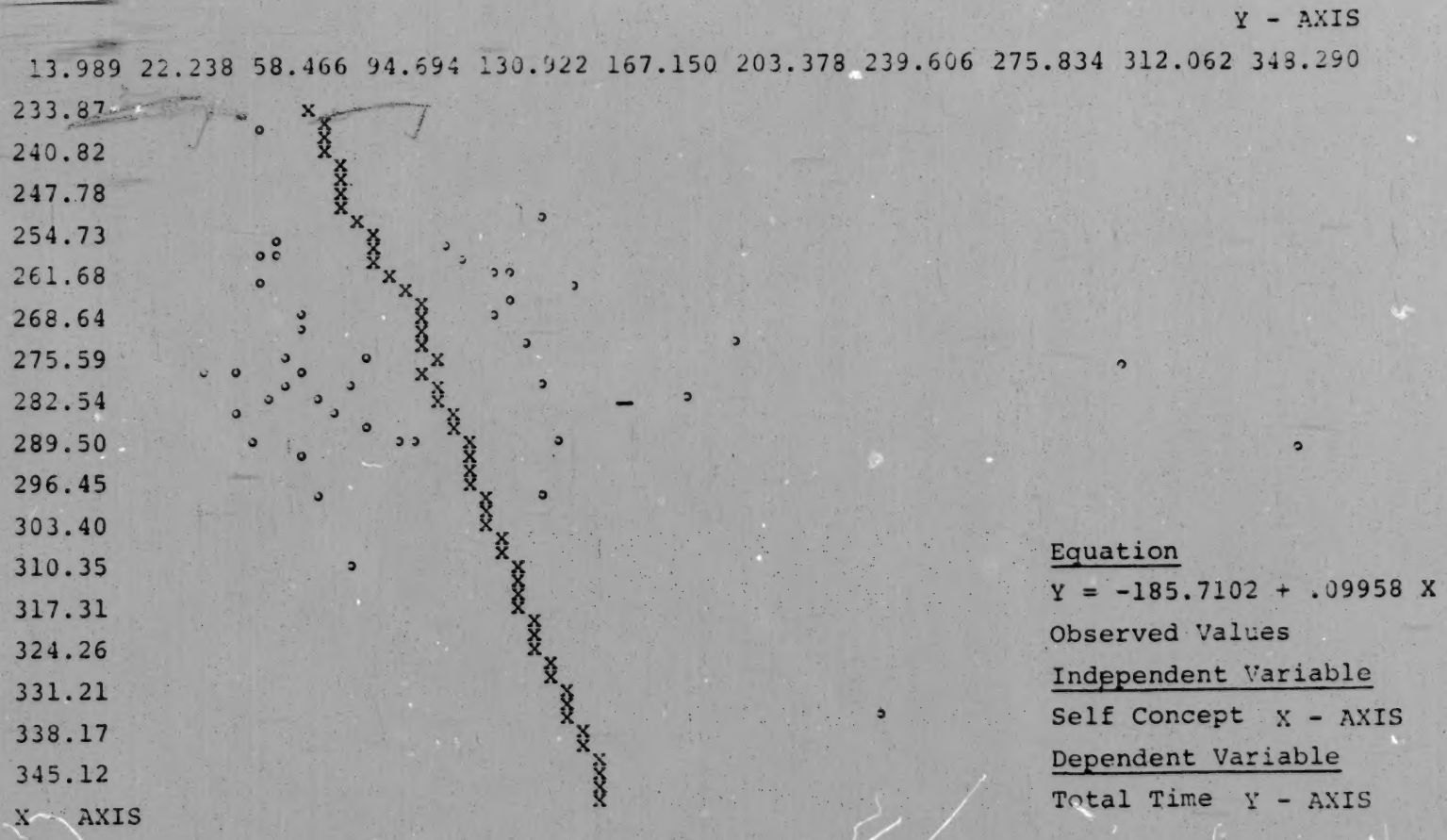

Figure 8. Plotted polynomial equation, self concept, response total time, groups I, II, and III

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Table 5. Analysis of variance table within group I, for dependent variable gains

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES
REGRESSION	1	152.68691	152.68691
ERROR	14	1930.15057	137.86789
TOTAL	15	2082.83749	

R-SQUARE = 0.07330 STANDARD ERROR = 11.74171

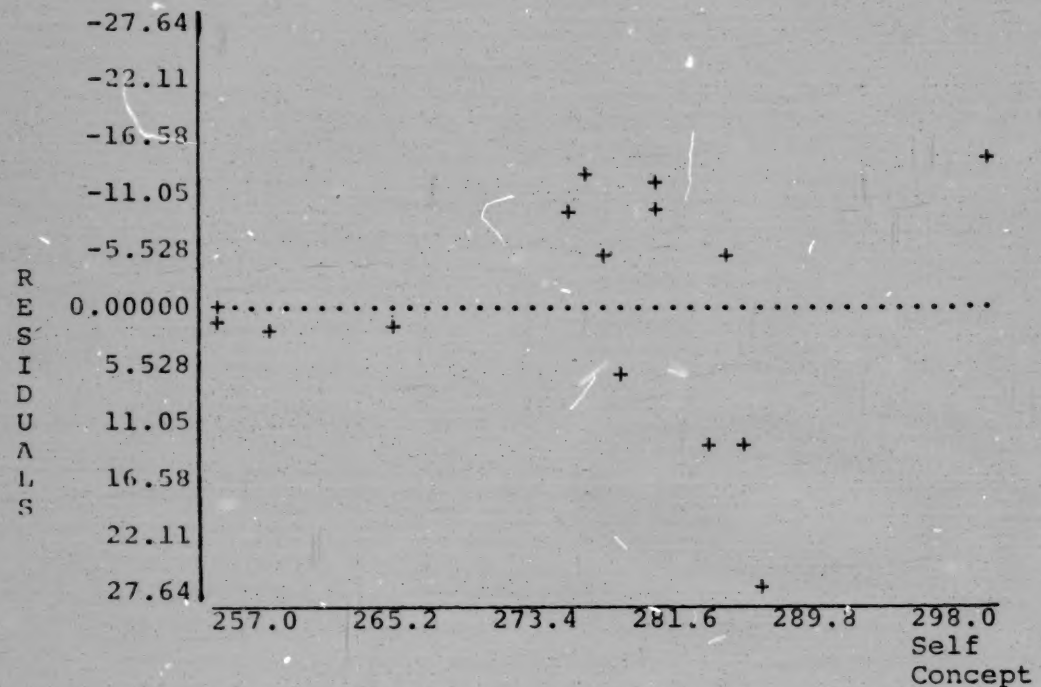

Figure 9. Plot residuals for gains vs self concept for group I

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Table 6. Analysis of variance table within group II, for dependent variable gains

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES
REGRESSION	1	57.93961	57.93961
ERROR	14	6407.43476	457.67391
TOTAL	15	6465.37438	
R-SQUARE = 0.00896		STANDARD ERROR =	21.39331

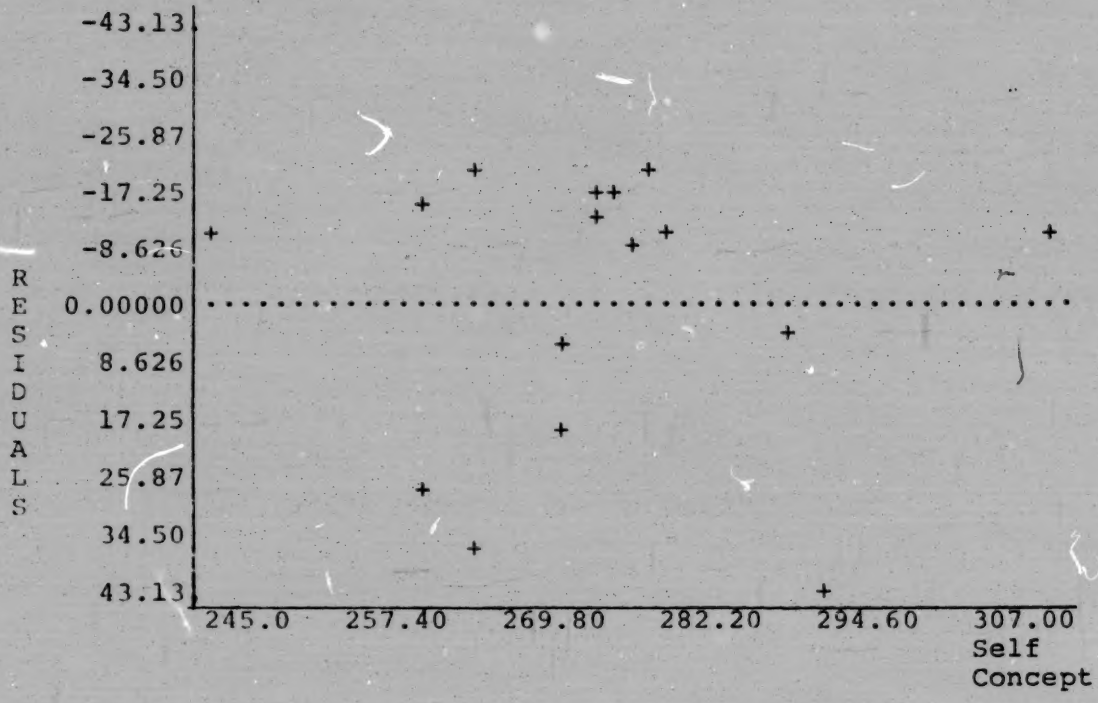

Figure 10. Plot residuals for gains vs self concept for group II

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Table 7. Analysis of variance table within group III, for dependent variable gains

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES
REGRESSION	1	68.36145	68.36145
ERROR	14	2390.87792	170.77699
TOTAL	15	2459.23938	
R-SQUARE = 0.02779		STANDARD ERROR =	13.06816

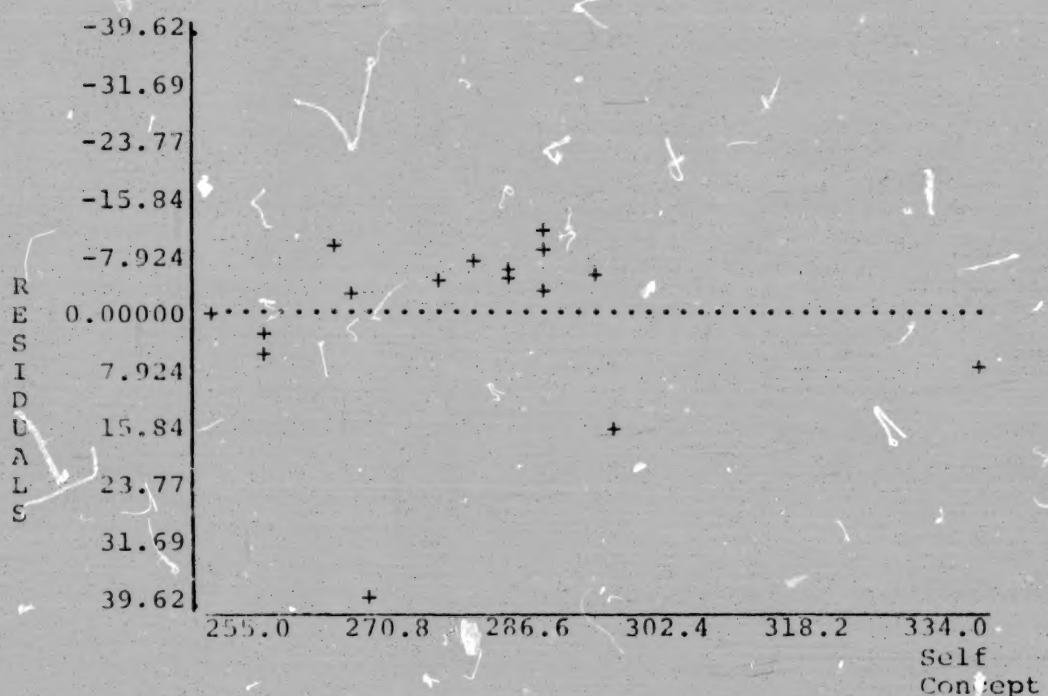

Figure 11. Plot residuals for gains vs self concept for group III

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Table 8. Analysis of variance table within group I, for dependent variable achievement

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES
REGRESSION	1	405.94881	405.94881
ERROR	14	5286.78556	377.62754
TOTAL	15	4692.73438	
R-SQUARE = 0.07130		STANDARD ERROR =	19.43264

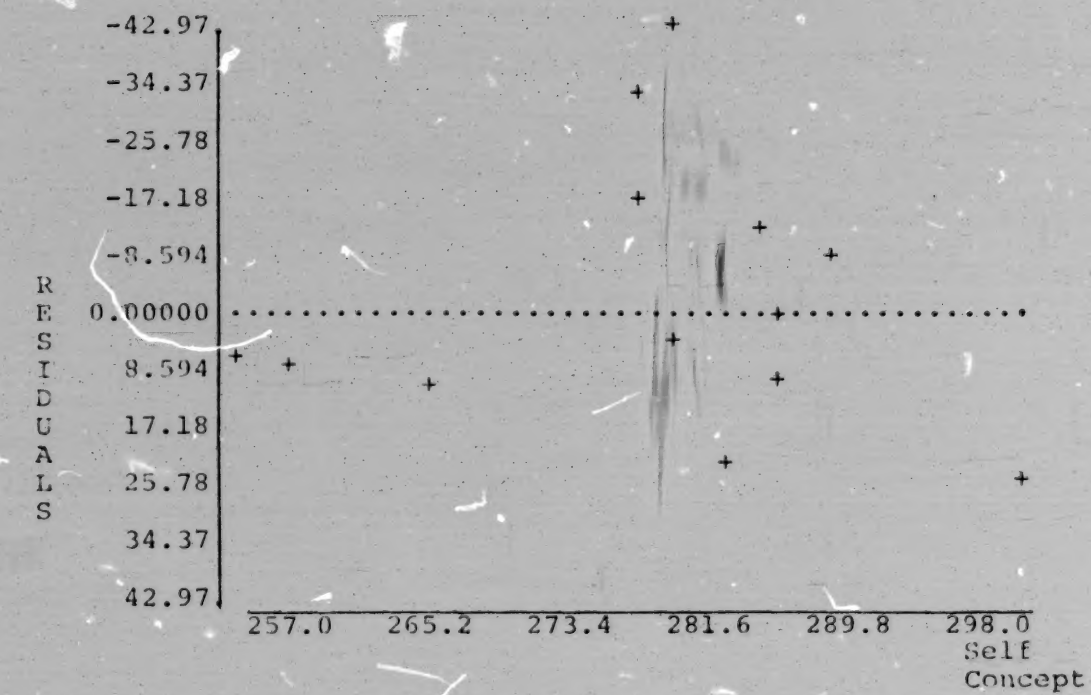

Figure 12. Plot residuals for achievements vs self concept for group I

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Table 9. Analysis of variance table within group II, for dependent variable achievement

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	75.48500	75.48500
ERROR	14	5359.45250	382.81803
TOTAL	15	5434.93750	
R-SQUARE =	0.01388	STANDARD ERROR =	19.56573

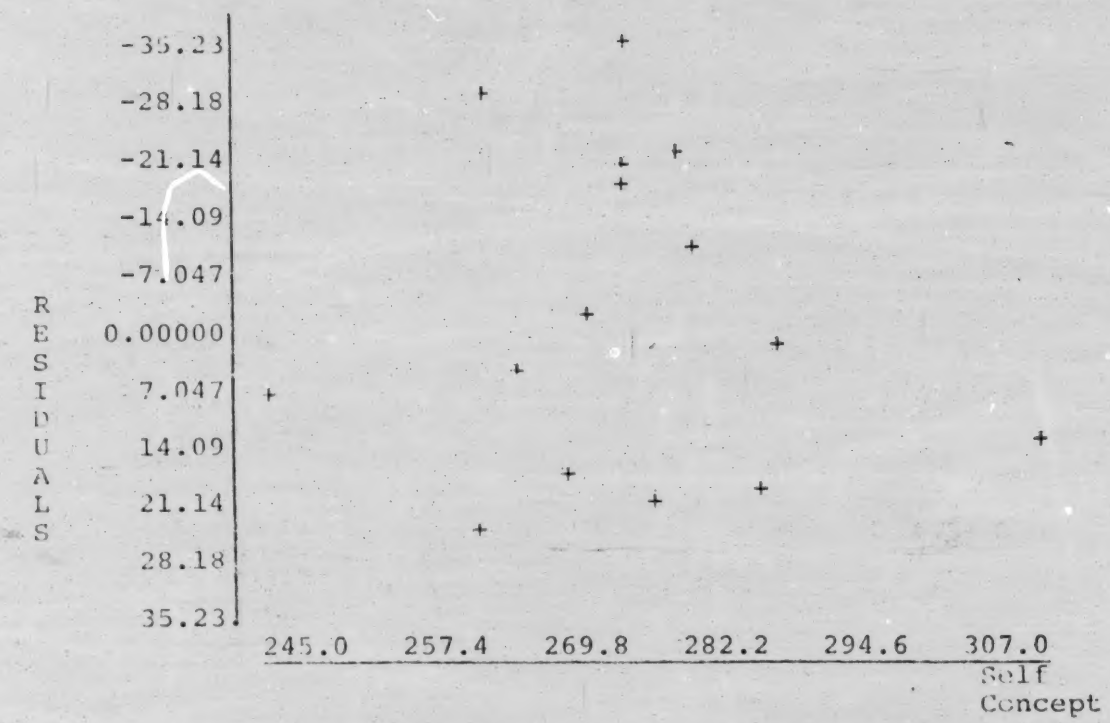

Figure 13. Plot residuals for achievements vs self concept for group II

Table 10. Analysis of variance table within group III, for dependent variable achievement

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	2117.02198	2117.02198
ERROR	14	6276.72801	448.33771
TOTAL	15	8393.75000	
R-SQUARE = 0.25221		STANDARD ERROR -	21.17398

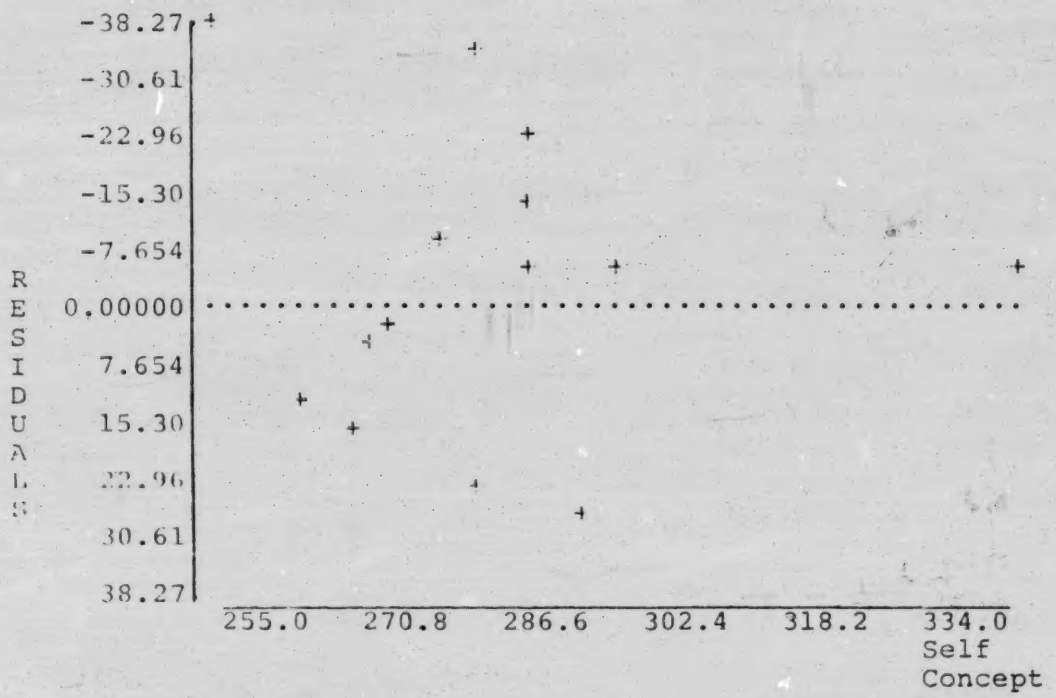

Figure 14. Plot residuals for achievements vs self concept for group III

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Table 11. Analysis of variance table within group I, for dependent variable total time

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	431.43719	431.43719
ERROR	14	21903.58021	1564.54144
TOTAL	15	22335.01741	
R-SQUARE =	0.01931	STANDARD ERROR =	39.55428

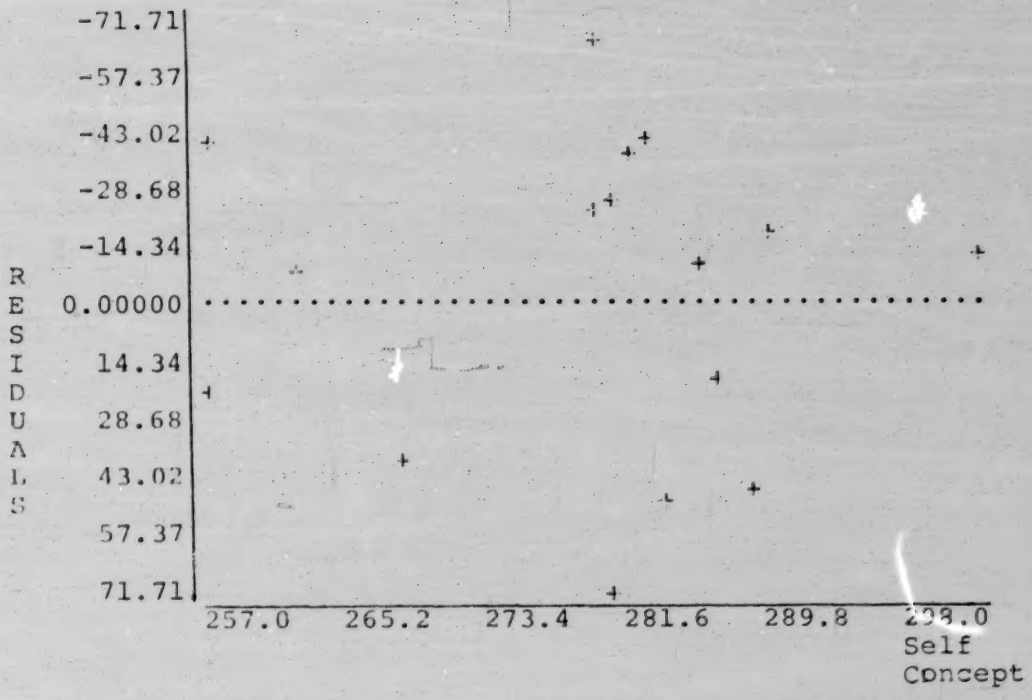

Figure 15. Plot residuals for total time vs self concept for group I

Table 12. Analysis of variance table within group II, for dependent variable total time

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	1070.55139	1070.55139
ERROR	14	50687.20339	3620.51452
TOTAL	15	51757.75480	
R-SQUARE =	0.02068	STANDARD ERROR =	60.17071

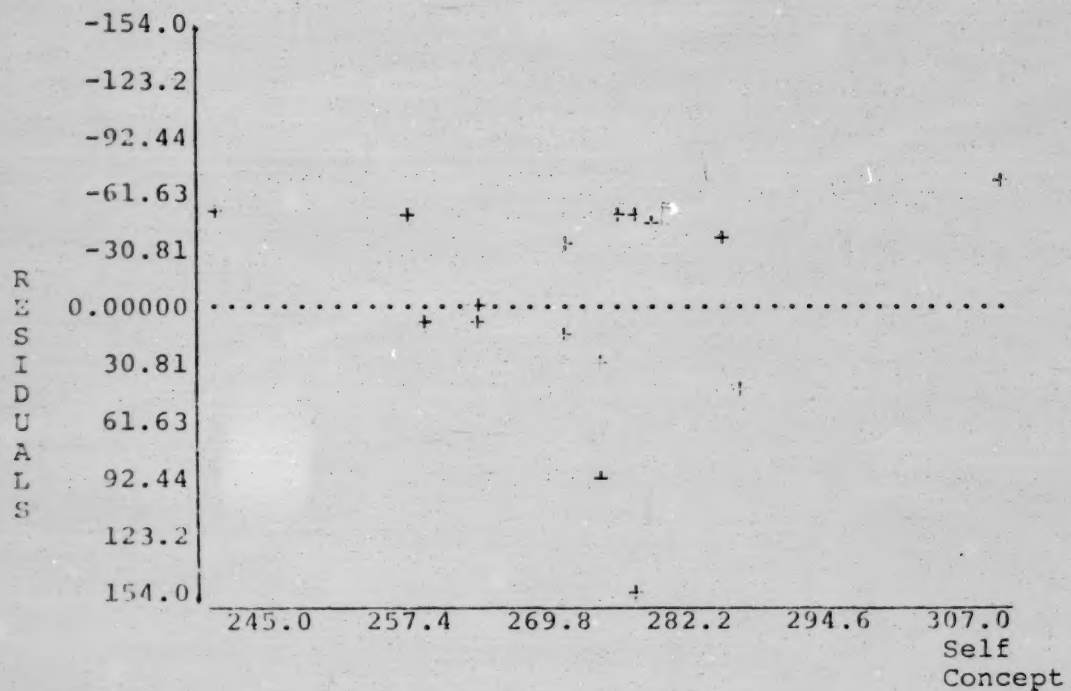

Figure 16. Plot residuals for total time vs self concept for group II

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Table 13. Analysis of variance table within group III, for dependent variable total time

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	19830.02369	19830.02369
ERROR	14	56574.00076	4041.00005
TOTAL	15	66404.02447	
R-SQUARE =	0.25954	STANDARD ERROR =	63.56886

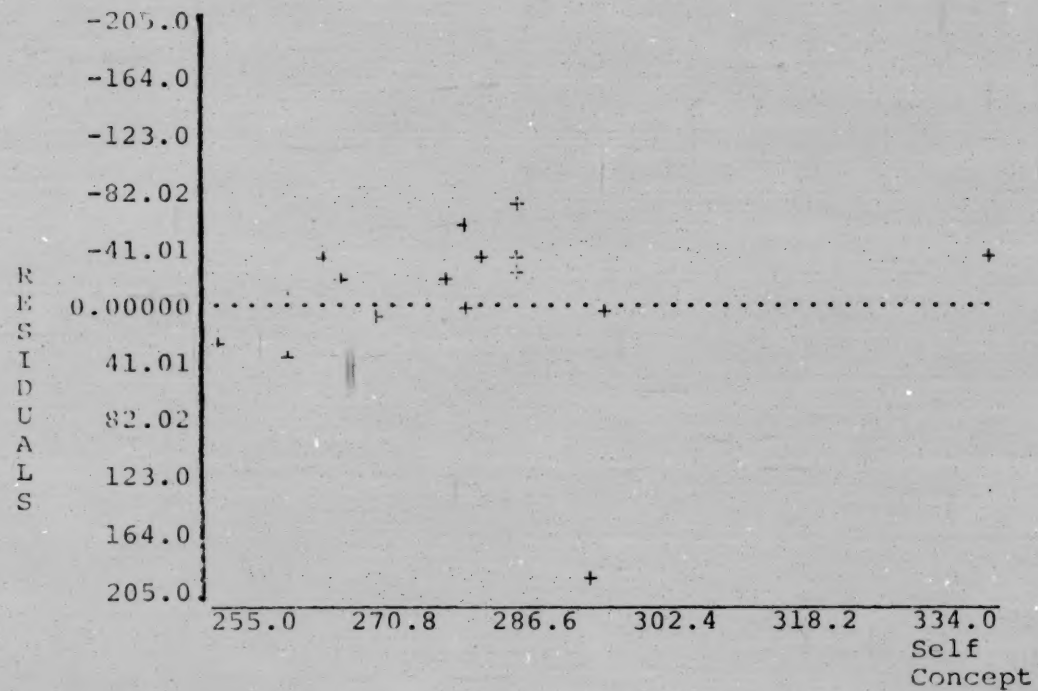

Figure 17. Plot residuals for total time vs self concept for group III

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Table 14. Analysis of variance table within group I, for dependent variable total trials

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	6204.21727	6204.21727
ERROR	14	23639.53273	1688.53805
TOTAL	15	29843.75002	
R-SQUARE =	0.20789	STANDARD ERROR =	41.09182

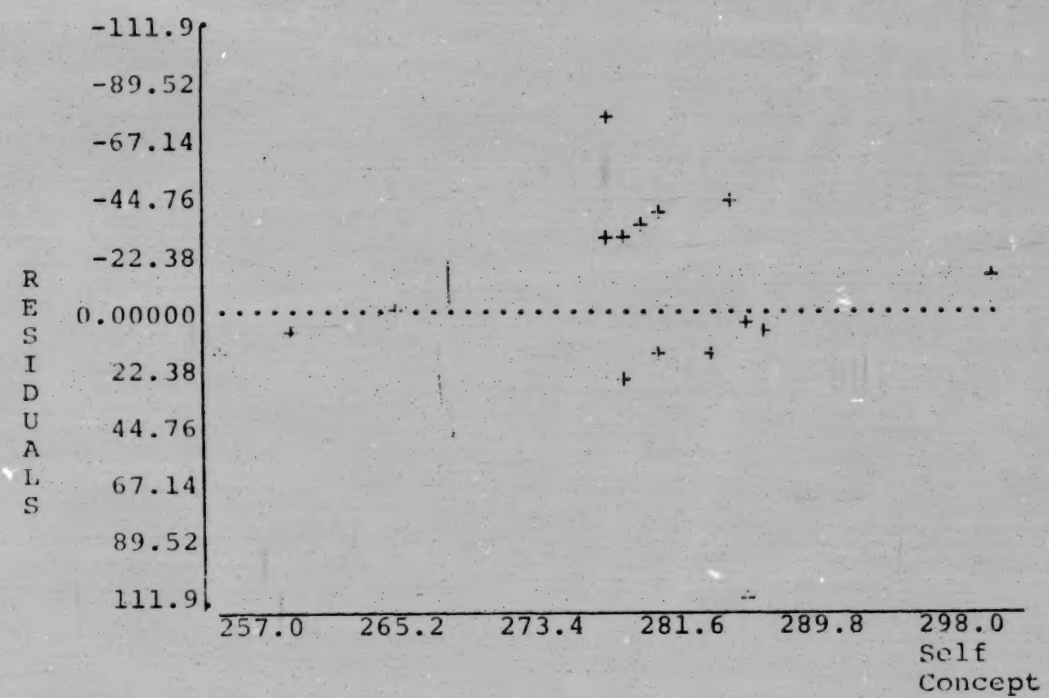

Figure 18. Plot residuals for total trials vs self concept for group I

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Table 15. Analysis of variance table within group II, for dependent variable total trials

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	8708.21534	8708.21534
ERROR	14	64885.53471	4634.68104
TOTAL	15	73593.75009	
R-SQUARE =	0.11832	STANDARD ERROR =	68.07849

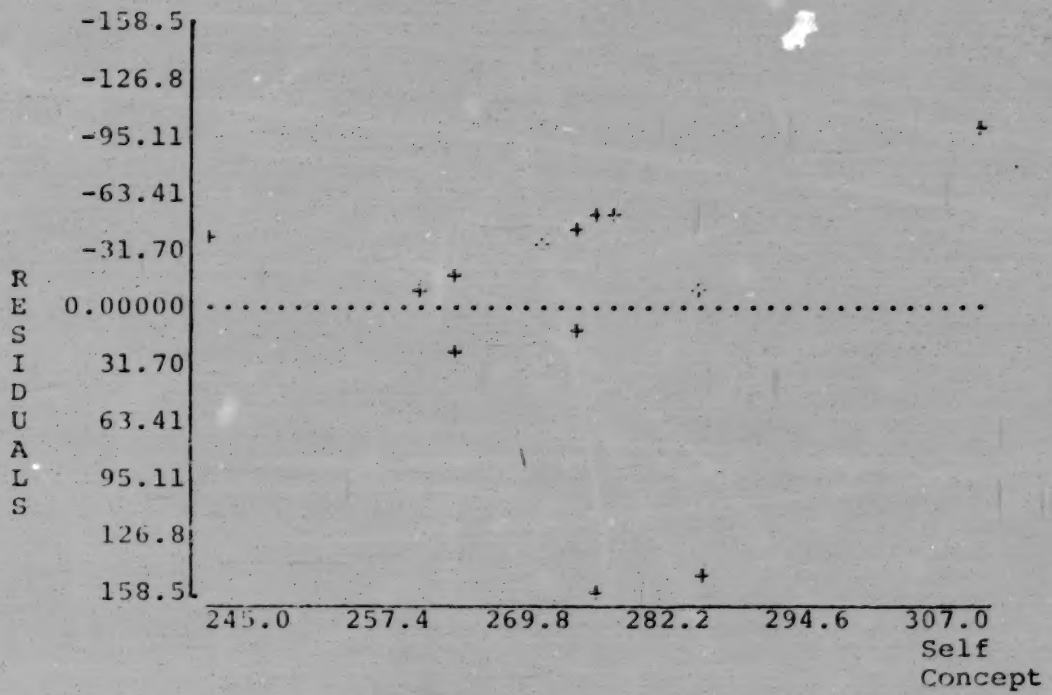

Figure 19. Plot residuals for total trials vs self concept for group II

Table 16. Analysis of variance table within group III, for dependent variable total trials

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	20567.10627	20567.10627
ERROR	14	58807.89378	4200.56384
TOTAL	15	79375.00009	
R-SQUARE = 0.35911		STANDARD ERROR =	64.81175

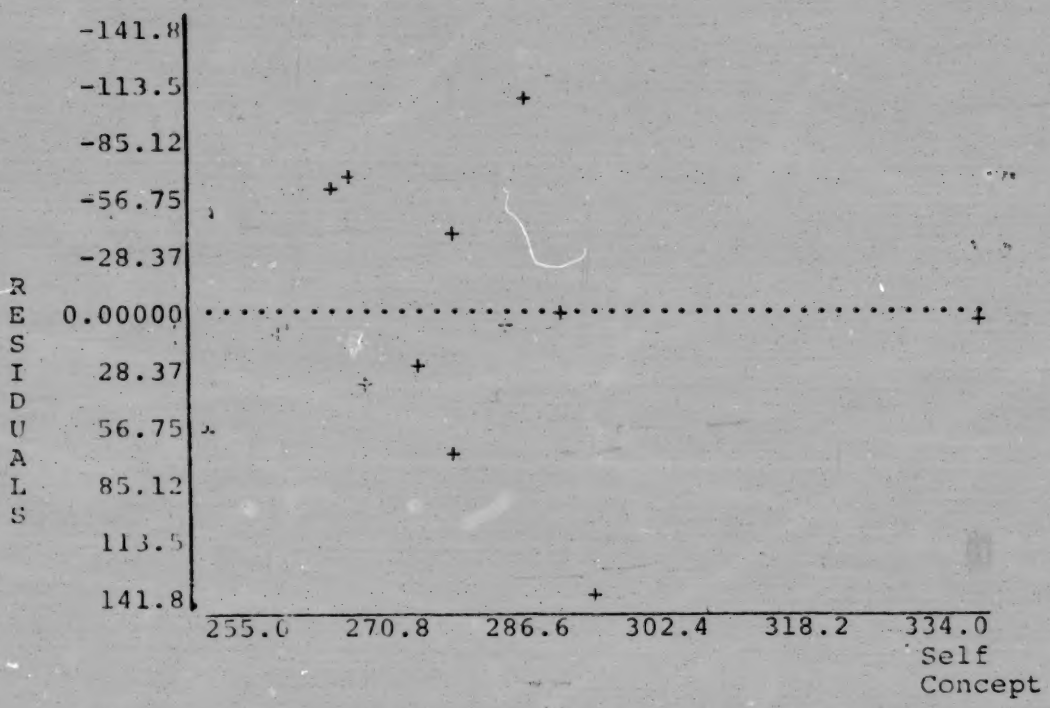

Figure 20. Plot residuals for total trials vs self concept for group III

Table 17. Analysis of variance table within group I, for dependent variable total errors

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	69.81287	69.81287
ERROR	14	741.62462	52.97318
TOTAL	15	811.43750	
R-SQUARE =	0.08603	STANDARD ERROR =	7.27826

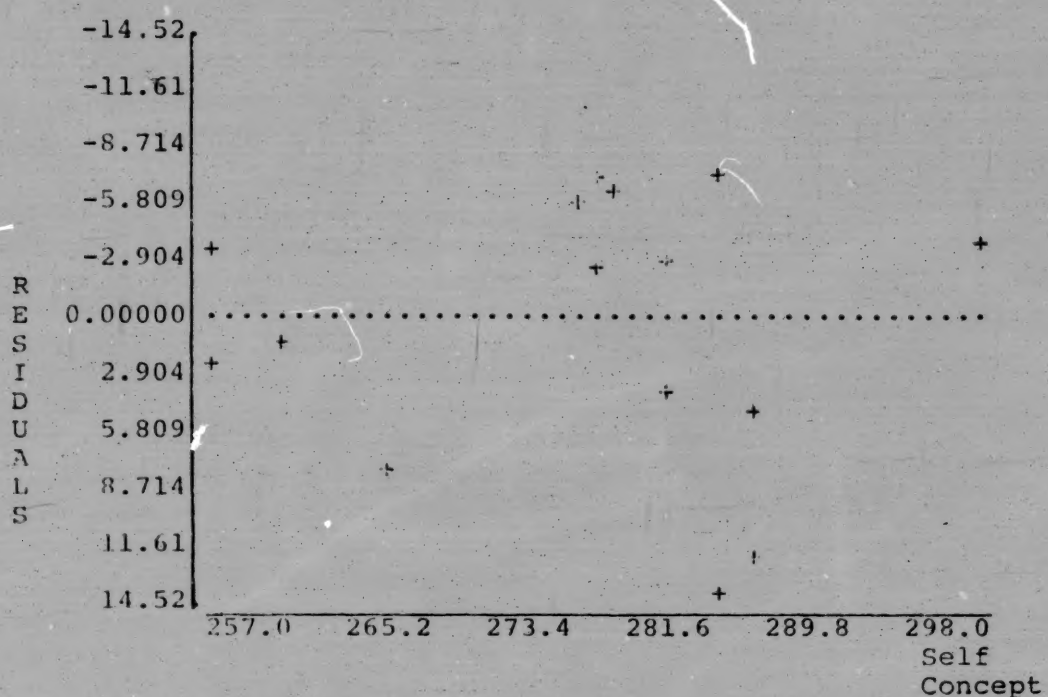

Figure 21. Plot residuals for total errors vs self concept for group I

Table 18. Analysis of variance table within group II, for dependent variable total errors

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	57.67095	57.67095
ERROR	14	988.07904	70.57707
TOTAL	15	1045.75000	
R-SQUARE =	0.05514	STANDARD ERROR =	8.40101

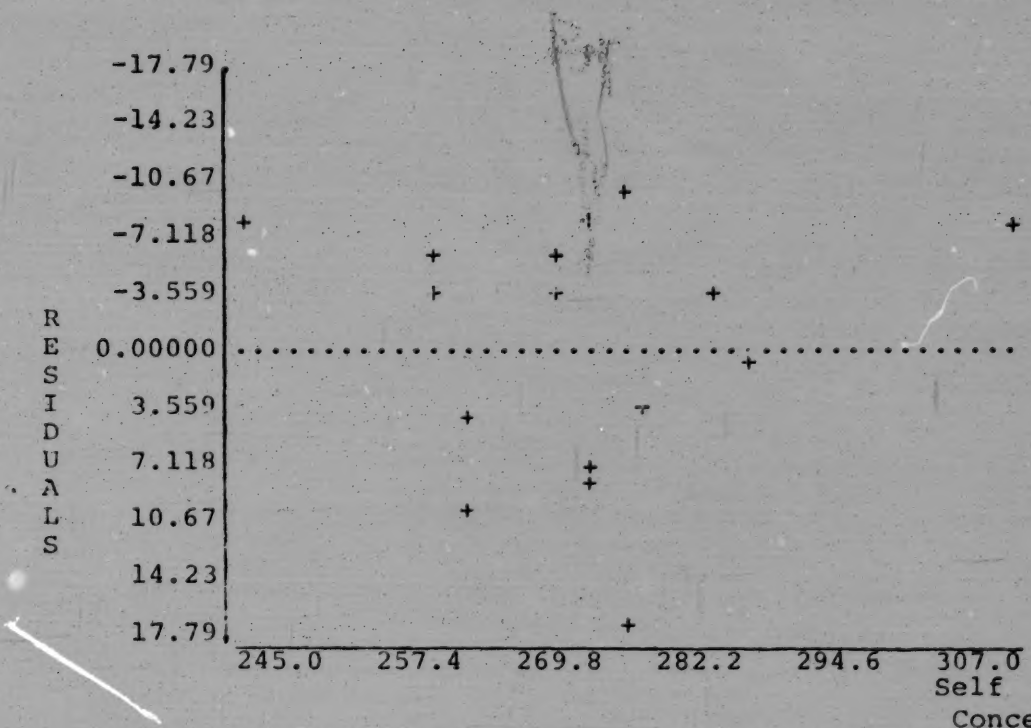

Figure 22. Plot residuals for total errors vs self concept for group II

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Table 19. Analysis of variance table within group III, for dependent variable total errors

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	2313.16543	2313.16543
ERROR	14	3266.83457	233.34532
TOTAL	15	5580.00000	
R-SQUARE =	0.41454	STANDARD ERROR =	15.27564

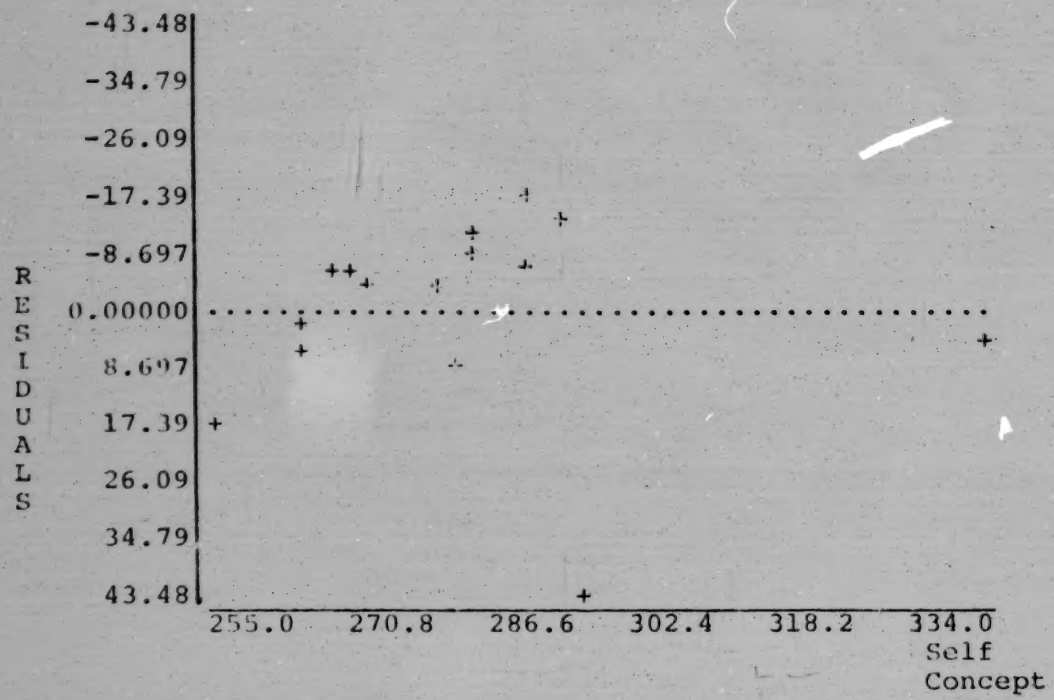

Figure 23. Plot residuals for total errors vs self concept for group III

Table 20. Analysis of variance table for dependent variable gains, group I, II, and III

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	4.03782	4.03782
ERROR	46	12023.81220	261.38722
TOTAL	47	12027.85002	
R-SQUARE = 0.00033		STANDARD ERROR =	16.16747

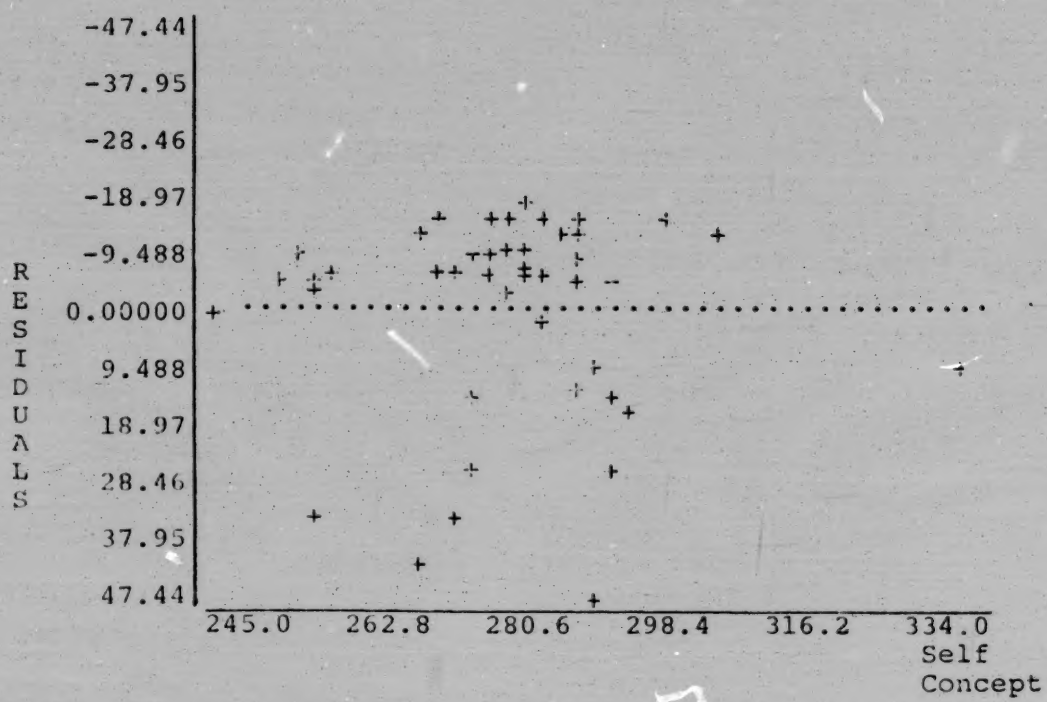

Figure 24. Plot residuals for gains vs self concept for groups I, II, and III

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Table 21. Analysis of variance table for dependent variable achievement, groups I, II, and III

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	1465.84837	1465.84837
ERROR	46	18591.72976	404.16803
TOTAL	47	20057.57814	
R-SQUARE = 0.07308		STANDARD ERROR = 20.10393	20.10393

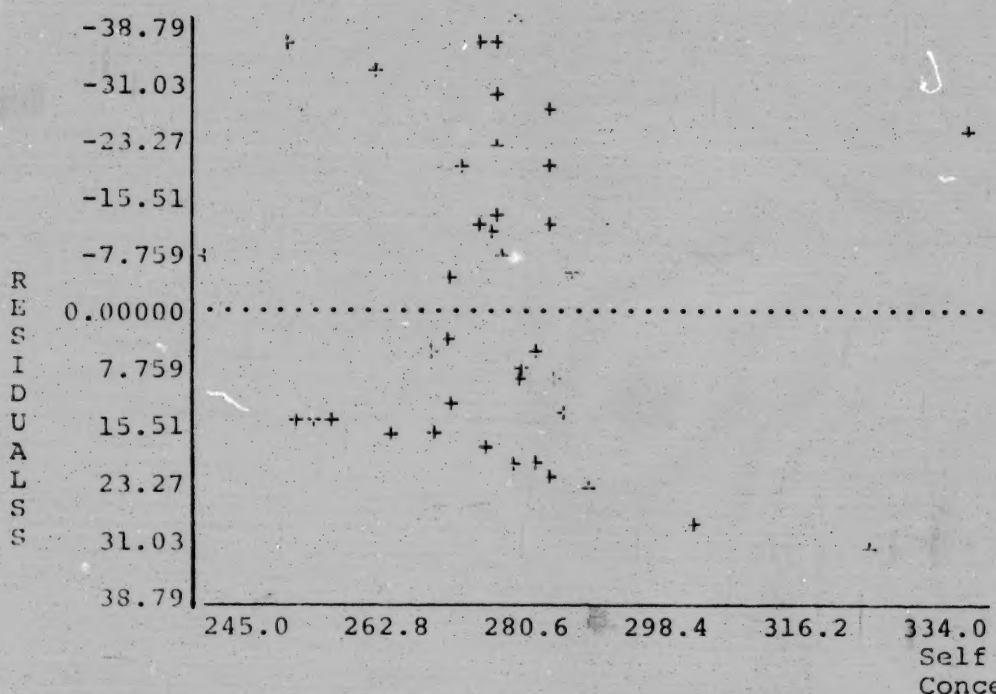

Figure 25. Plot residuals for achievement vs self concept for groups I, II, and III

Table 22. Analysis of variance table for dependent variable total time, groups I, II, and III

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	10387.49537	10387.49537
ERROR	46	144009.24255	3130.63570
TOTAL	47	154396.73791	
R-SQUARE =	0.06727	STANDARD ERROR =	55.95208

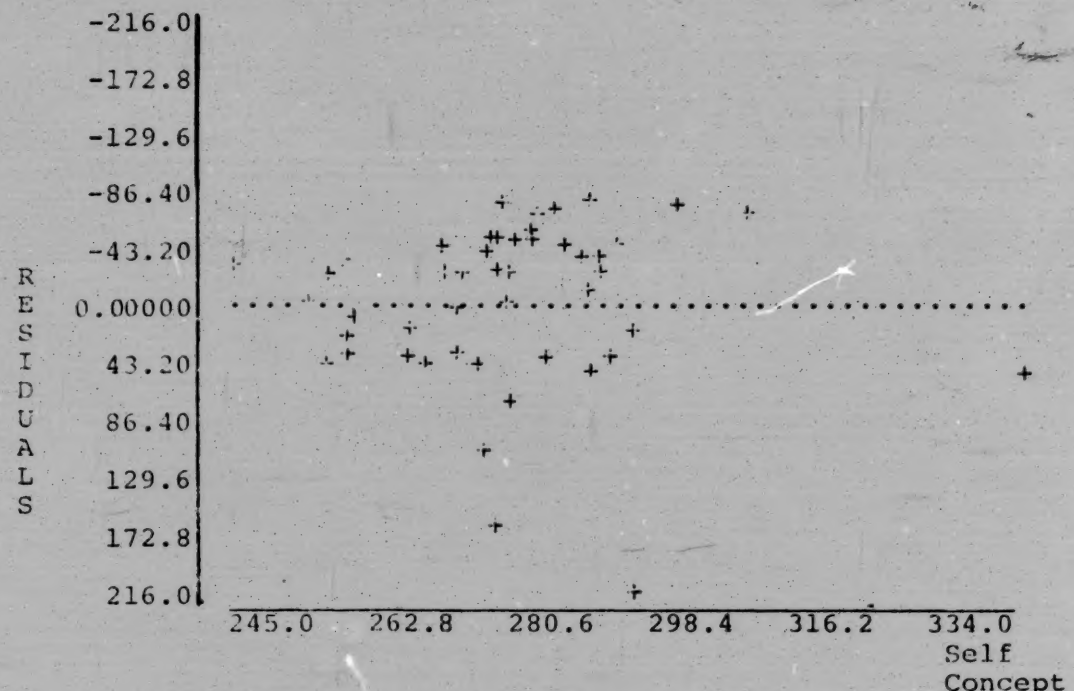

Figure 26. Plot residuals for total time vs self concept for groups I, II, and III

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Table 23. Analysis of variance table for dependent variable total trials, groups I, II, and III

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	32882.80275	32882.80375
ERROR	46	151283.86297	3288.77963
TOTAL	47	184166.66668	
R-SQUARE =	0.17854	STANDARD ERROR =	57.34788

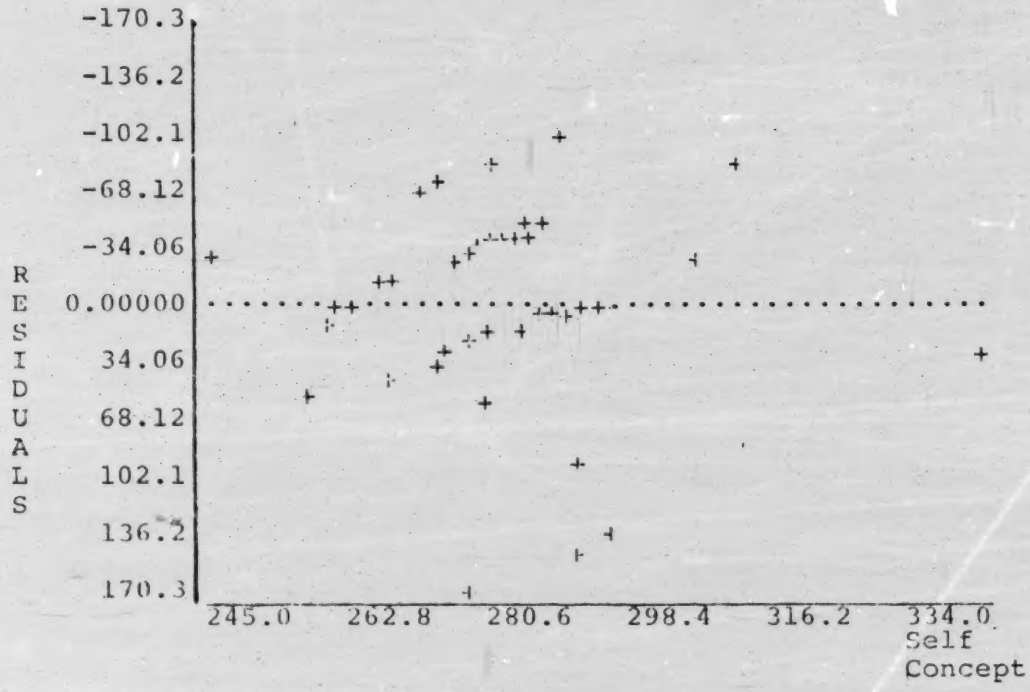

Figure 27. Plot residuals for total trials vs self concept for groups I, II, and III

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Table 24. Analysis of variance table for dependent variable total errors, groups I, II, and III

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	1734.30833	1734.30833
ERROR	46	5789.67083	125.86240
TOTAL	47	7523.97916	
R-SQUARE =	0.23050	STANDARD ERROR =	11.21884

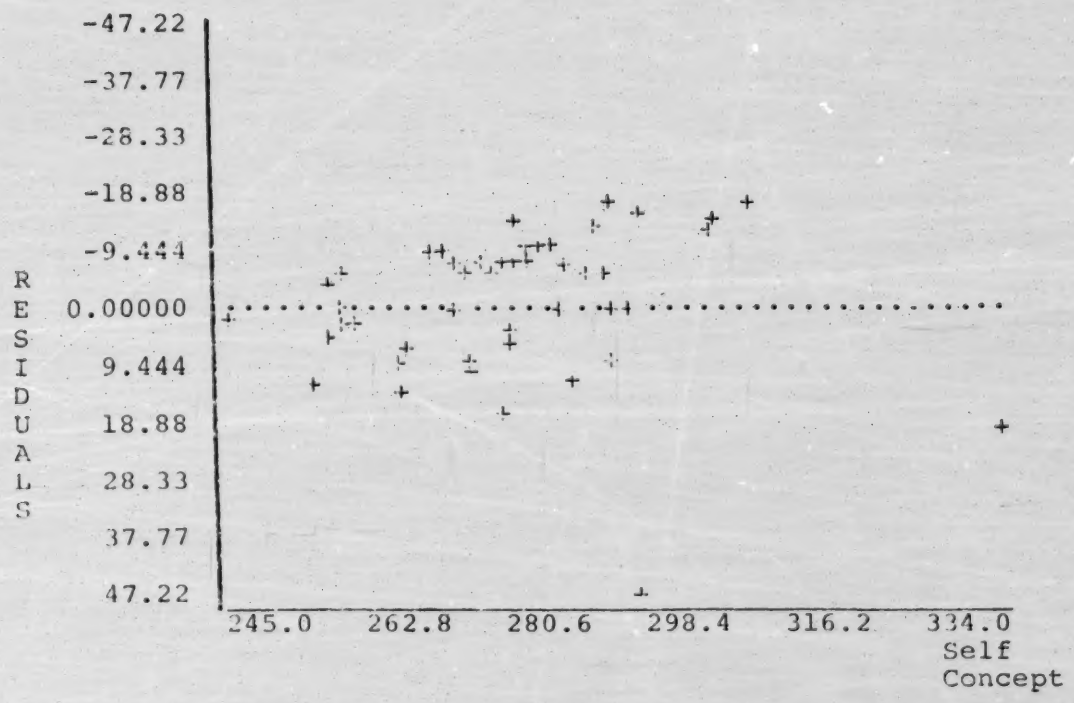

Figure 28. Plot residuals for total errors vs self concept for groups I, II and III

Table 25. Simple statistics for analysis of covariance for group 1

VARIABLE	SUM	MEAN	UNCOR SS	COR SS	VARIANCE	ST. DEV.
SELF CONCEPT	4428.00000	276.75000	1227466.00097	2017.00000	134.46666	11.59597
GAINS	255.00000	15.93750	6148.89999	2082.83749	138.85583	11.78371
ACHIEVEMENT	1336.50000	83.53125	117332.25006	4692.73438	379.51562	19.48116
TOTAL TRIALS	1950.00000	121.87500	267500.00036	29843.75002	1989.58333	44.60474
TOTAL TIME	1223.39999	76.46249	115879.23965	22335.01741	1489.00116	38.58757
TOTAL ERRORS	149.00000	9.31250	2199.00000	811.43750	54.09583	7.35498

Table 26. Matrix of correlation coefficients for group 1

	SELF CONCEPT	GAINS	ACHIEVEMENT	TOTAL TRIALS	TOTAL TIME	TOTAL ERRORS
SELF CONCEPT	1.00000	0.27075	-0.26703	0.45594	-0.13898	0.29331
GAINS	0.27075	1.00000	-0.06867	0.49807	-0.06445	0.67022
ACHIEVEMENT	-0.26703	-0.06867	1.00000	-0.02001	-0.00833	0.06180
TOTAL TRIALS	0.45594	0.49807	-0.02001	1.00000	0.52088	0.76013
TOTAL TIME	-0.13898	-0.06445	-0.00833	0.52088	1.00000	0.42008
TOTAL ERRORS	0.29331	0.67022	0.06180	0.76013	0.42008	1.00000

Table 27. Simple statistics for analysis of covariance for group II

VARIABLE	SUM	MEAN	UNCOR SS	COR SS	VARIANCE	ST. DEV.
SELF CONCEPT	4351.00000	271.93750	1186053.00097	2852.93750	190.19583	13.79115
GAINS	427.69999	26.73124	17898.32999	6465.37438	431.02495	20.76114
ACHIEVEMENT	1281.00000	80.06250	107995.00009	5434.93750	362.32916	19.03494
TOTAL TRIALS	2150.00000	134.37500	362500.00036	73593.75009	4906.25000	70.04462
TOTAL TIME	1562.09999	97.63124	204267.52984	51757.75480	3450.51698	58.74110
TOTAL ERRORS	186.00000	11.62500	3208.00000	1045.75000	69.71666	8.34965

Table 28. Matrix of correlation coefficients for group II

	SELF CONCEPT	GAINS	ACHIEVEMENT	TOTAL TRIALS	TOTAL TIME	TOTAL ERRORS
SELF CONCEPT	1.00000	-0.09466	0.11785	0.34398	0.14381	0.23483
GAINS	-0.09466	1.00000	0.38779	0.33501	-0.05268	-0.13530
ACHIEVEMENT	0.11785	0.38779	1.00000	-0.18672	-0.45185	-0.56695
TOTAL TRIALS	0.34398	0.33501	-0.18672	1.00000	0.79512	0.65045
TOTAL TIME	0.14381	-0.05268	-0.45185	0.79512	1.00000	0.81690
TOTAL ERRORS	0.23483	-0.13530	-0.56695	0.65045	0.81690	1.00000

Table 29. Simple statistics for analysis of covariance for group III

VARIABLE	SUM	MEAN	UNCOR SS	COR SS	VARIANCE	ST. DEV.
SELF CONCEPT	4455.00000	278.43750	1245679.00097	5239.93750	349.32916	18.69034
GAINS	295.29999	18.45624	7909.36999	2459.23938	163.94929	12.80426
ACHIEVEMENT	1206.00000	75.37500	99296.00006	8393.75000	559.58333	23.65551
TOTAL TRIALS	2100.00000	131.25000	355000.00024	79375.00009	5291.66667	72.74384
TOTAL TIME	1479.69999	92.48124	213248.52941	76404.02447	5093.60163	71.36947
TOTAL ERRORS	200.00000	12.50000	8080.00000	5580.00000	372.00000	19.28730

Table 30. Matrix of correlation coefficients for group III

	SELF CONCEPT	GAINS	ACHIEVEMENT	TOTAL TRIALS	TOTAL TIME	TOTAL ERRORS
SELF CONCEPT	1.00000	0.16672	-0.50220	0.50903	0.50945	0.64385
GAINS	0.16672	1.00000	-0.05137	0.53372	0.18633	0.40137
ACHIEVEMENT	-0.50220	-0.05137	1.00000	-0.48185	-0.07358	-0.55057
TOTAL TRIALS	0.50903	0.53372	-0.48185	1.00000	0.47684	0.89330
TOTAL TIME	0.50945	0.18633	-0.07358	0.47684	1.00000	0.37315
TOTAL ERRORS	0.64385	0.40137	-0.55057	0.89330	0.37315	1.00000

Table 31. Analysis of variance between groups on variable, gains

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	VARIANCE COMPONENTS
Corrected Total	47	12027.8500		
Treatment	2	1020.3987	510.1993	16.5993
Expt. Error	45	11007.4512	244.6100	244.6100

Standard Error of Diff. 5.5295 Least Standard Difference at the 05. level 9.2896

Table 32. Analysis of variance between groups on variable, achievement

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	VARIANCE COMPONENTS
Corrected Total	47	20057.5781		
Treatment	2	536.1562	268.0781	-10.3582
Expt. Error	45	19521.4218	433.8093	433.8093

Standard Error of Diff. 7.3638 Least Standard Difference at the 05. level 12.3712

Table 33. Analysis of variance between groups and variable, total trials

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	VARIANCE COMPONENTS
Corrected Total	47	184166.6666		
Treatment	2	1354.1665	677.0832	-211.5885
Expt. Error	45	182812.5001	4062.5000	4062.5000

Standard Error of Diff. 22.5346 Least Standard Difference at the .05 level 37.8582

Table 34. Analysis of variance between groups and variable, total time

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	VARIANCE COMPONENTS
Corrected Total	47	154396.7379		
Treatment	2	3899.9426	1949.9713	-87.1501
Expt. Error	45	150496.7952	3344.3732	3344.3732

Standard Error of Diff. 20.4461 Least Standard Difference at the .05 Level 34.3495

Table 35. Analysis of variance between groups and variable, total errors

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	VARIANCE COMPONENTS
Corrected Total	47	7523.9791		
Treatment	2	86.7916	43.3958	-7.6171
Expt. Error	45	7437.1875	165.2709	165.2708

Standard Error of Diff. 4.5452 Least Standard Difference at the .05 Level 7.6359

Table 36. Analysis of variance between groups and variable, latency rate

SOURCE	DF	SUM OF SQUARES	MEAN SQUARES	VARIANCE COMPONENTS
Corrected Total	47	2.8968		
Treatment	2	0.1279	0.0639	0.0001
Expt. Error	45	2.7689	0.0615	0.0615

Standard Error of Diff. 0.0877 Least Standard Difference at the .05 Level 0.1473

Table 37. Means and estimated treatment effects for each Group X performance criterion measures

	Group I		Group II		Group III		
	Means	Estimate	Means	Estimate	Means	Estimate	.05 level LSD
Gains	15.9375*	-4.437	26.7312*	.6.356	18.4562	-1.918	9.28
Ach	85.5312	3.875	80.0625	.0462	75.3750	-4.2812	12.37
Total Time	76.4624	-12.3958	97.6312	8.772	92.4812	3.622	34.34
Total Trials	121.875	-7.2916	134.375	5.2083	131.250	2.083	37.85
Total Errors	9.312	-1.8333	11.6250	0.4791	12.5000	1.354	7.63
Rate	.2667	-0.023	.3617	0.0716	.2418	-.0482	.14
Grand Mean							

*Significant at the .05 level.

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Table 38. Treatment means X performance

	Gain	Achievement	Trials	Time	Total Error
Self Concept I	.27	-.26	.46*	-.14	.29
II	-.09	.12	.34	.14	.23
III	.17	-.50*	.51*	.51*	.64*
Total	.02	-.27	.42*	.26*	.48*

	Achievement	Trials	Time	Total Error
Gains I	-.07	.50*	-.06	.67*
II	.39	.34	-.05	-.14
III	-.05	.53*	.19	.40
Total	.11	.42*	.07	.22

	Trials	Time	Total Error
Achievement I	-.02	-.01	.06
II	-.19	-.45	-.57*
III	-.49*	-.07	-.55*
Total	-.28	-.19	-.42

	Time	Total Error
Trials I	.52*	.76*
II	.79*	.65*
III	.47*	.89*
Total	.60*	.77*

	Total Error
Time I	.42*
II	.82*
III	.37*
Total	.47*

*Significant at .05 level

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SUMMARY, DISCUSSION AND RECOMMENDATIONS

Summary

The purpose of this investigation was to compare the effects of three schedules of reinforcement, 0%, 30% and 100% on learning performances of undereducated adults enrolled in a CAI IPI level D arithmetic program involving five skills in the area of fractions; and further, to study the correlation of these effects with Ss self concept scores as measured by the Tennessee Self Concept Inventory. A treatment program was constructed from the IPI program as originally designed by the Research for Better Schools, Philadelphia, Pennsylvania, for presentation to Ss via the IBM 1500 Instructional System. The Tennessee Self Concept Inventory was adapted for CAI presentation. The program varied in three ways, 0%, 30%, and 100% positive reinforcements. All programs utilized knowledge of results following every response.

The Ss for this study were 48 adults voluntarily enrolled at the North Carolina Adult Learning Resources Center in Spring of 1970. Each had less than a high school education and each placed at level D (approximately 4th grade) in fractions on the computer-managed IPIPT (Individually Prescribed Instruction Placement Test).

Ss were black women, most of whom had children, were husbandless, were on welfare, and were being paid a stipend to

gain adequate educational skills for a high school equivalency diploma to be qualified to enter a competitive labor market, and become self sustaining and able to relinquish welfare benefits. Ss were randomly assigned to one of three treatment groups. There were 16 Ss in each treatment group. After placement at level D fractions, Ss took a pencil and paper pre-test to assess their entering mastery of the five skills to be taught. Ss engaged in CAI sessions on fractions, consisting of 50-trial sessions, until their error rate had dropped below 5% on a completed session. Number of sessions ranged from 1 to 6; all Ss had at least 50 problem trials, varying in multiples of 50 up to a maximum of 300 problem trials. Ss were self-paced. When errors dropped below 5%, Ss took a paper and pencil post-test to assess achievement of the five skills in fractions. Self concept scores obtained and processed via CAI for all enrollees as part of the initial guidance program of the Center were utilized as an independent correlated variable in this study. The dependent variables (criterion measures) for this study were: (a) pretest -post-test gains, (b) percentage achievement, (c) total time to complete the CAI program, (d) total trials, (e) total errors and (f) learning rate. The dependent variables were evaluated for level of significance by analysis of covariance, one-way analysis of variance and by a multiple regression program. All variables are shown in Table 39.

Table 39. Variables of the study

Independent Variables

Treatment	Conditions
A_1	100% knowledge of results 0% positive reinforcement random assignment
A_2	100% knowledge of results 30% positive reinforcement random schedule random assignment
A_3	100% knowledge of results 100% positive reinforcement random assignment
B	Self concept scores Self assigned

Dependent Variables

Variable	Criterion
Y_1	Total gains
Y_2	Percentage Achievement
Y_3	Total Time in tenths of minutes
Y_4	Total Trials to acquisitions
Y_5	Total Errors to acquisition
Y_6	Learning rate

Table 40. Random assignment of Ss into treatment groups

No Reinforcement	Variable Ratio 30% Reinforcement	Continuous Reinforcement
Group I	Group II	Group III
n = 16	n = 18*	n = 18*

*2 Ss were randomly eliminated to equalize the groups.

Discussion of Findings

The hypotheses of this experiment are listed in Chapter I and tested in chapter IV. The following is a brief discussion of the findings concluded from the testing of the hypotheses.

Self Concept Variable

There is a significant relationship between self concept and treatment effects on achievement, rate of learning and error rate. There is a relationship between self concept and 100 percent reinforcement on all dependent variables except actual pre-post test gains. Self concept, as measured by the Tennessee Inventory, was related to the effectiveness of praise statements on CAI learning for this sample. The preliminary test of sample homogeneity disclosed that self concept scores distributed randomly over a very narrow range.

The sample of self concept scores is significantly different from Fitts' normal population of self concept scores. (See Figure 29). The sample does exhibit a normal distribution but different from the Tennessee Normed Sample. Within the normed distributions, means as low as the research sample mean would have occurred less than .02 percent of the time. Scores this low should predict maladjustment and incapacitating emotional problems. The research sample, on the contrary, is composed of highly motivated, self directed, attractively composed, socially competent, striving and constructive black mothers. Whatever their socio-economic

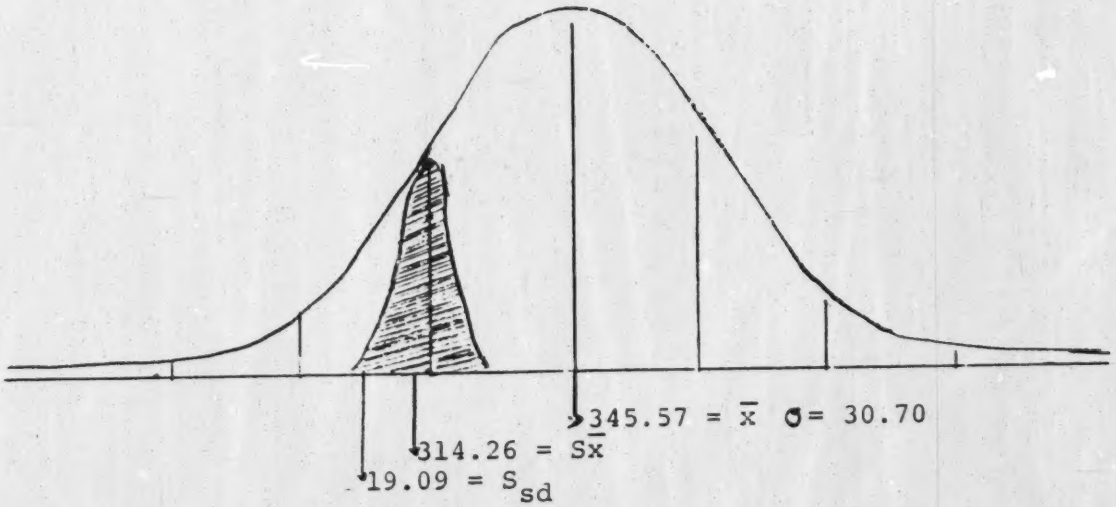

Figure 29. The normal and sample distribution of total P scores of the Tennessee Self Concept Inventory

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situation is, they have adjusted to it to the extent that they are not patients in mental hospitals nor are they alienated from their own ethnic group. The high significance of the difference between the sample and the normed group suggests a possibility of some inadequacy in the assumption of self concept inventory content validity as an adjustment instrument. In this instance its utilization as a discriminator of social and emotional maladjustment is not upheld.

This description of the self concept characteristic of the sample may be the most significant finding of the study. Effective social reinforcements for this sample may be quite different from those of other socia-economic or ethnic groups.

Self Concept and Dependent Variables

There are significant relationships between self concept scores and outcomes: gains, percentage achievement, trials, time and errors. Those obtained included:

(a). A negative relationship between self concept and achievement, i.e. high self concept obtained lower achievement. This could be interpreted to indicate for this sample that those Ss more sure of themselves tended to be careless and less concerned about increasing their achievement level. They entered the CAI activity with less motivation to gain mastery than low self concepts. They may have perceived less need for attention to accuracy. They may have engaged in more accurate guessing and thus reached an errorless level

on the instruction. Their fastest scores then reflected inadequate mastery. This interpretation must be accepted with caution as no control for guessing was provided. The negative relationship showing could be due to inaccurate self concept measures, inadequate sample size, or other variables operating in the CAI situation not brought under control in the research design.

(b). A weak relationship exists between total trials, time and errors on the variable self concept ($r = .43$). Higher self concepts required slightly more trials to reach errorless mastery. This relationship is not unusual if the reasoning for the interpretation of (a) above is accepted. For this sample, if higher self confidence resulted in carelessness, guessing and low level achievement, then this same trait would reflect more errors, more trials and thus more time. Trials, time and errors are confounded in this CAI instructional design. An increase in errors precluded an increase in the others.

Another way to examine these variables is to compute and compare rates. Times per trial, gains per trial, gains per time and trials per gain were computed. Table 41 displays these four rates within treatment groups for above average and below average self concepts. Figures 30-33 display graphic comparisons of these rates. It should be noted that differences between means for above and below averages exist; had the samples been larger, significant differences might have

been exposed. If treatment operated independently on any of the four rates it was not significantly identified. The within-group differences are generally greater than between-group differences. Group II displays a greater within-group difference on gain rate over time and trials than does group I or group III. In group II Ss with higher self concepts achieved considerably more gain points per minute of trial time than low self concepts. Also, within group II Ss with higher self concepts (Figure 30) took more trials. They took more trials and total time but were more efficient, they earned more points for each trial than either of the other two groups.

The pattern of behavior on time per trial was similar for each group, low self concepts (Figure 33) took sightly more time than higher self concepts, with group II taking the most time. Figure 30 displays the uniqueness of group II again; here higher self concepts required more trials for each gain point than low self concepts. This pattern is the reverse for groups I and III. Within group I self concept makes no difference; whereas, in group III self concept makes some difference. Continuous praise of high self concepts produced more errors. Also, the higher the self concept the more time it took to mastery, praise acted as a distractor.

Table 41. Learning rates within treatment groups for above average and below average self concept scores

	GROUP I		GROUP II		GROUP III	
	ABOVE AVE SC	BELOW AVE SC	ABOVE AVE SC	BELOW AVE SC	ABOVE AVE SC	BELOW AVE SC
Trials/Gain	9.90	10.00	9.70	6.00	6.50	7.70
Gain/Trial	.15	.21	.12	.41	.18	.16
Gain/Minute	3.50	.94	14.10	3.20	7.20	3.70
Time/Trial	.46	.74	.77	.91	.79	.64

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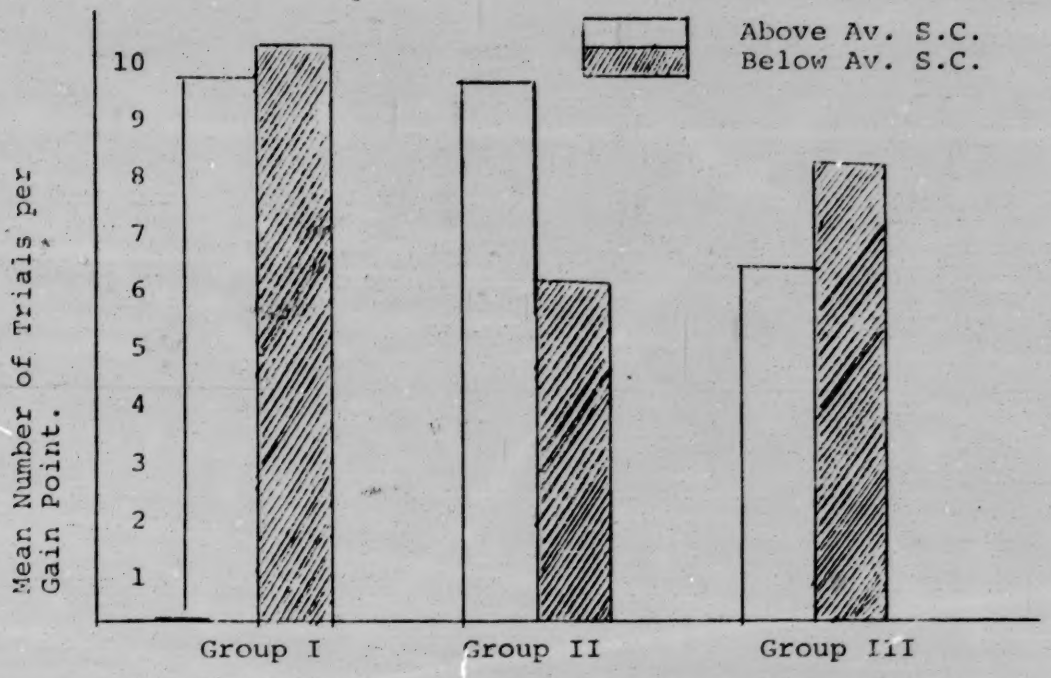

Figure 30. Mean number of trials per gain for above average and below average self concepts within each treatment group

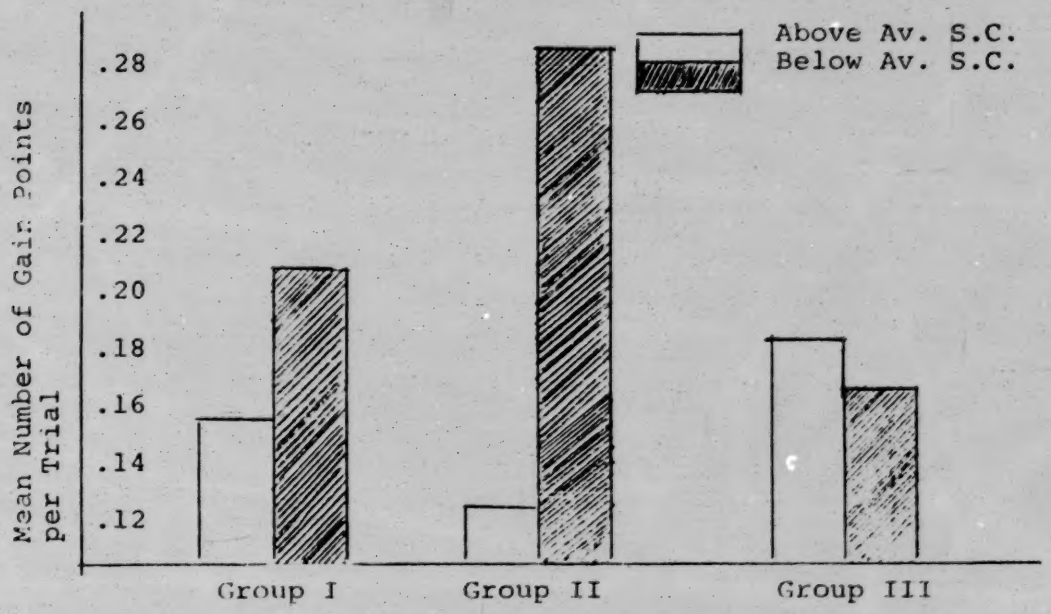

Figure 31. Mean number of gains per trial for above average and below average self concepts within treatment groups

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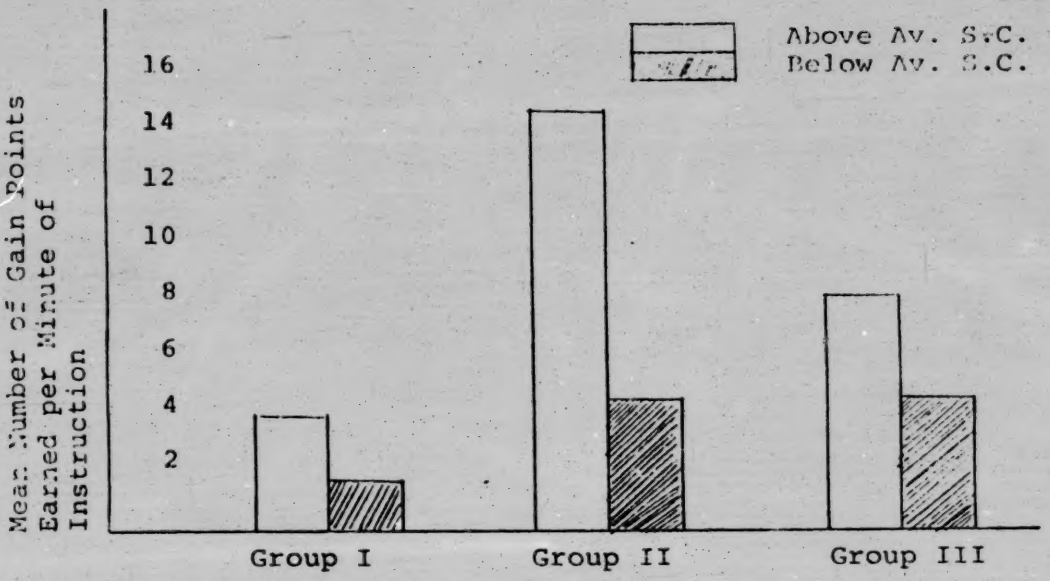

Figure 32. Mean number of gains per minute for above and below average self concepts within treatment groups

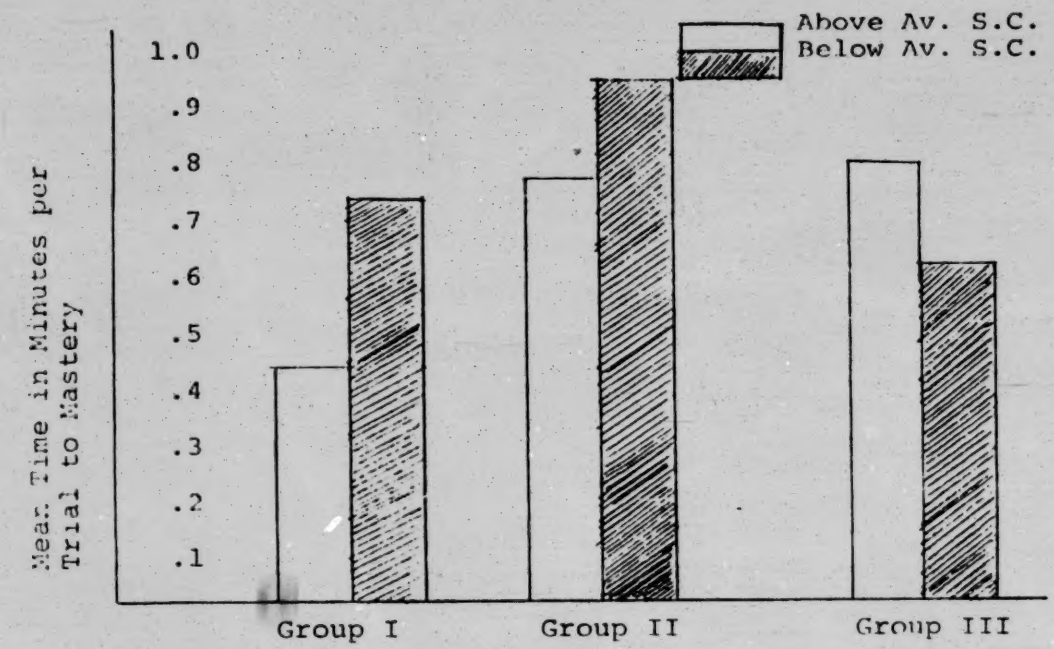

Figure 33. Mean number of minutes per trial for above and below average self concepts within treatment groups

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Knowledge of Results vs Praise Statements

Knowledge of results was provided all Ss of the study for each response, additionally groups II and III received praise statements. The group receiving knowledge of results did not perform significantly different from the other groups on percentage achievement, error rate, response rate, or learning rate (gains per minute). It was expected that the addition of praise statements to knowledge of results would accelerate and increase learning.

Knowledge of results or simple confirmation may be the reinforcement contingency that best fits Skinners' S-R paradigm. This finding must be interpreted with caution since there was no control for knowledge of results. Had a group been included who received no knowledge of results, and a group who received only praise statements, a more definitive concept of reinforcement could have been tested.

Reinforcement Treatment Variable

There is no significant difference among the treatments on percentage achievement, error rate, total trials, total time or learning rate. There is a significant relationship between reinforcement schedule and amount of gain on an immediate retention (postest) test. 30% variable-ratio schedule praise statements treatment group achieved significantly greater gains than did the no praise statements group, but there is no significant difference between the 30% variable schedule groups and 100% continuous schedule group nor between the no praise statement group and the 100% continuous schedule group.

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Since praise statements were assumed to be learned secondary reinforcers it was expected that the praise statement group would make less errors. The concept of individual differences and self pacing was a basic assumption of the study, even so, it was expected, from treatment effects, that the praise statements groups would take less trials and time to master the 5 skills embedded in the CAI fractions module. It was also expected that treatment would effect greater gains and percentage achievement.

Self Concept and Treatment Effect

The data indicated that knowledge of results was less effective than praise. Higher self concepts took less time but made more errors. Low self concepts took more time and trials but made more gains per trial.

30% schedule was most effective for all groups on time, errors and trials. Higher self concepts obtained higher percentage achievement. Low self concepts took less trials per gain and made more gains per minute.

100% praise schedule was more effective than knowledge-of-results-only. Higher self concepts took more trials per minute, made more errors and more achievement than the other groups. They indicated a faster response time. The above observations suggest that self concept is related to effectiveness of verbal praise schedules.

From Figure 34 it can be observed that learners who made the least errors did not necessarily achieve the highest number of pretest - postest gain points. The postest was administered off the computer after instruction was completed or errorless. The postest was an outside criterion measure and could be considered a retention measure. Ss who experienced more practice trials to 150 made successively higher gains. Those Ss who continued to make errors beyond 150 trials were engaged in ineffective learning. Some factor other than variables in the study may have come under the control of the reinforcement stimulus. Table 42 indicates that those learners with the least enabling skills took more practice trials but actually made more gain points than Ss with errorless practice on 50 trials who already possessed considerable enabling level of mastery. For 85% of the samples, the more practice (and relatedly more errors) the more gain points achieved. The learning curve on Figures 35, 37 and 38 displays a close correspondence between the learning curve of Ss in the study and the classic learning curve. All groups exhibit a sharp drop in error rate and a leveling off over time which means that the principles of learning developed from studies of children and lower organisms apply to undereducated adults as well.

Figure 35 compares the mean learning rate of the three groups. Group I displays more erratic patterns than the others but over all they make less errors. It can be

Table 42. Pretest, post-test and gains as a function of sessions attended

Number of Sessions *	N	% Sample	Pretest	Post-Test	Gains
1	6	13	84.96	96.06	11.1
2	20	43	74.43	97.44	23.01
3	13	28	65.27	91.1	25.83
4+	7	15	55.96	73.03	17.01

*50 trials each

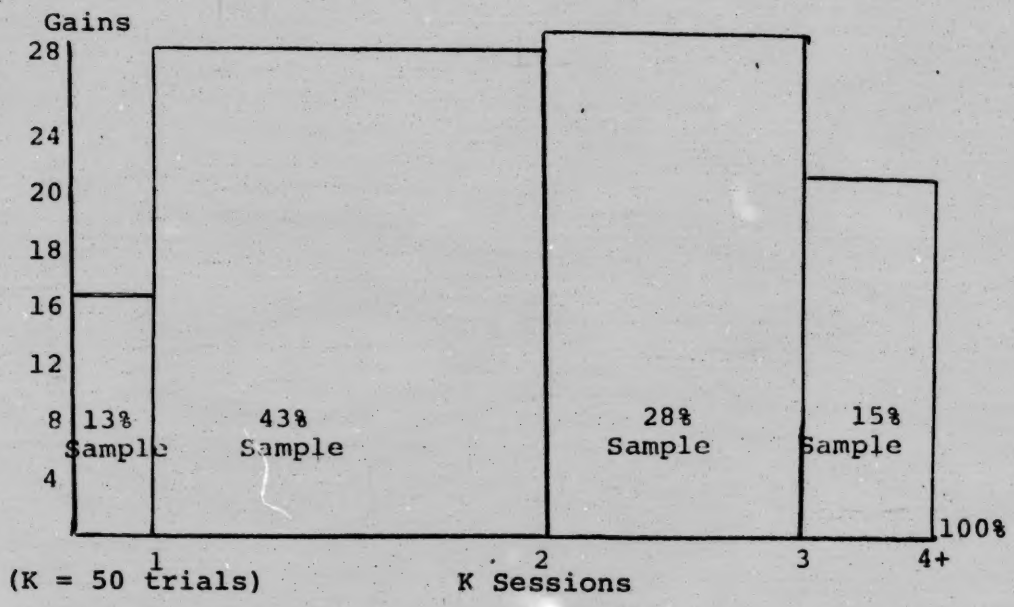


Figure 34. Proportion of sample making last error on session K

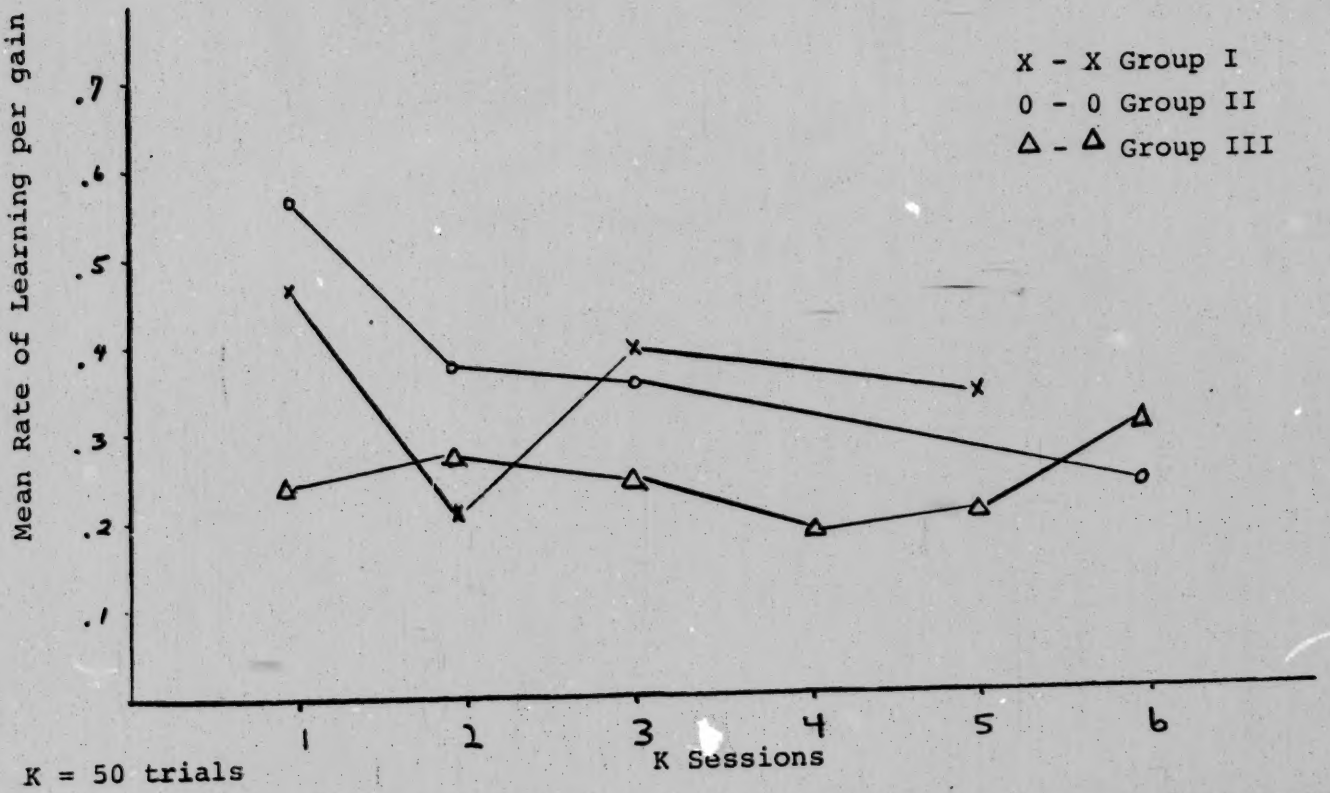
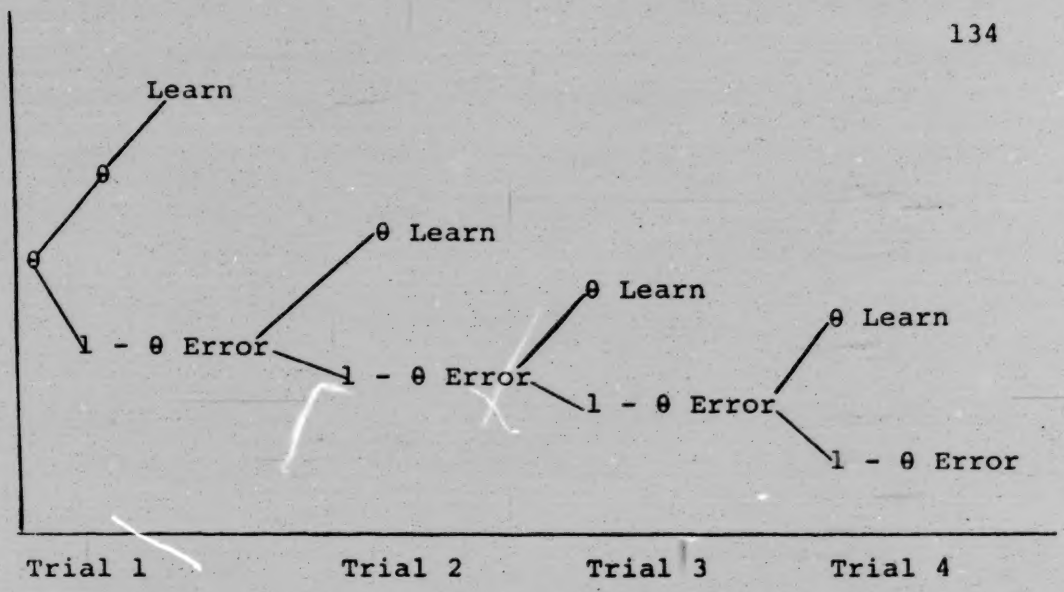


Figure 35. Mean learning rate for K session on which learner made last error



$$p(\text{learning on trial } n) = (1 - \theta)^{n-1}\theta$$

or

$$p(n) = 1 - (1 - \theta)^{n}$$

Figure 36. Tree diagram of probability of learning on any trial

seen that group II made the most errors but also made the most gains when trials were less than 150. Group III increased in learning rate over time whereas the other two groups, though leveling off, display a steady decline in efficiency. The effects of varied reinforcement are lessened over time.

Application to Learning Theory

Data from this investigation can be applied to a mathematical model of learning theory to answer some questions about CAI utilization with undereducated adults at the Adult Learning Resources Center. Data from this study can relate back to theory and assess the degree of accuracy that theory can predict to instructional practice. The situation of the Learning Center Laboratory is not too different from ABE Learning Laboratories across the States of North and South Carolina and Virginia so that tentative inferences can be made to those situations from this study. In this instance, inferences derived from theory-related data would be less suspect than predictions derived purely empirically. Selected questions which may be answered by theory include; how many practice trials, how much time and how many errors should Ss experience for maximal effectiveness and efficiency? Also, when instruction is programmed for self pacing by such devices as electronic teaching machines, what differences obtain due to differences between individuals? What is the effect of errors on learning? If practice extends beyond errorless trials,

does a pattern of extinctionless error-making creep into the activity? Is learning cumulative over time or is learning always all-or-none on each practice trial?

All-or-none theory states that single, unitary items such as math skills in the area of fractions, are learned as single events. No partial progress is made before or after the learning occurs. This thoery has been found to "...fit discrimination-learning and concept-formation experiments."[1] Before learning, S cannot pass a test on a skill; after learning, he can. Instructional trials, 1, 2,..., n,...until mastery provide opportunity to learn. The probability of learning on the first trial is θ. The probability of error is, $1 - \theta$. Theory states that there is no partial learning on trial 1, hence Ss who have not learned on trial 1 have not progressed. Thus the probability of learning on trial 2 is still θ if S did not learn on trial 1. According to this theory, a group of learners who are at the same level of ability will progress as in Figure 39. IPI Math was designed such θ (probability of learning on trial 1 is .85,) $1 - \theta$ is .15. (Figure 40 and 41 and Table 43)

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1 Restle, Frank. The Relevance of Mathematical Models for Education; p. 113, 63rd Yearbook of the National Society for the Study of Education. Part I, 1964

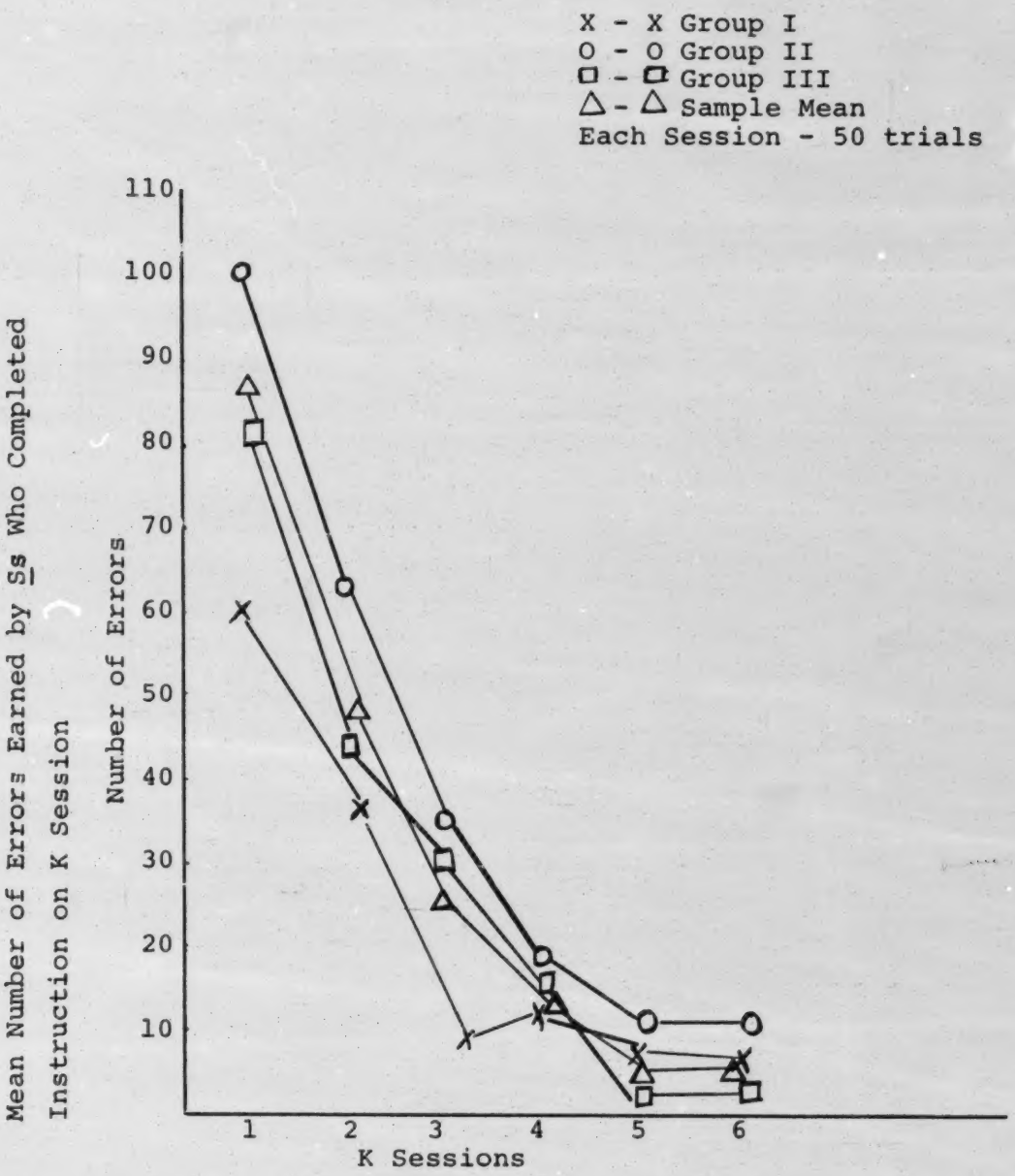

Figure 37. Number of K sessions learner attended before last error

Table 43. Theoretical vs sample data on the mean proportion of the possible number of items included in Trial K where last error occured

(IPI MATH, success = P.85; error = P.15; p(K) =1-.85)

Items Possible	p Errors	K	Items	p	Data	p
2550	p.15	1	382.5	.15	297	.12
2250	$p(2)=(1-\theta)\theta$	2	337.5	.13	163	.06
1050	$p(3)=(1-\theta)^2\theta$	3	157.5	.05	71	.03
350	$p(4)=(1-\theta)^3\theta$	4	52.5	.02	41	.02
300	$p(5)=(1-\theta)^4\theta$	5	4.5	.02	18	.01
200	$p(6)-(1-\theta)^5\theta$	6	3.0	.01	8	.003

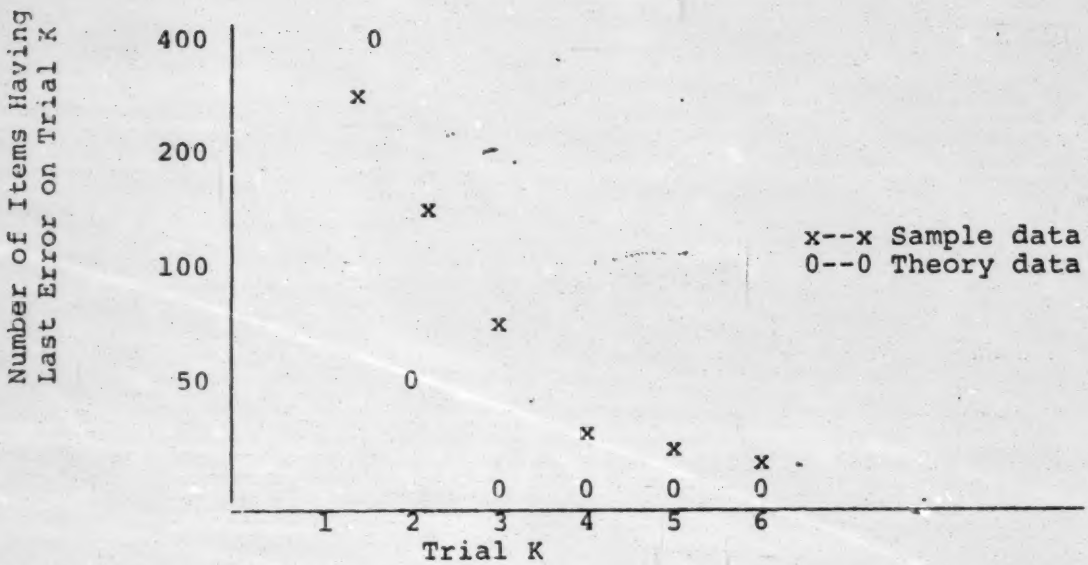

Figure 38. Sample learning curve vs theoretical learning curve--number of items having last error on Trial K (theoretical) (p error = 1 - p success)

All-or-none theory says that the distribution of trial of learning will be the geometric distribution of $p(n)=1-(1-\theta)^n$. The distribution of errors for this theoretical model and for Ss in the IPI research study appear in Table 43. Figures 39, 40, and 41 display comparisons of theoretical distribution to sample data.

Learning is also hypothesized to be cumulative over time. The following model portrays the theory that learning is a function of time: $p = F(t + h) - F(t)$. Here $F(t)$ is the probability of learning by the beginning of trial K; 1, 2, 3, ...n .; beginning $t = o$. The probability of learning within any interval $(t, t+h)$ is written $(F(t + h)-F(t)$.

The consequences of both models is about the same, although they are used with different data. Both models can be applied to this research study.

Table 45 and Figure 42 display a comparison of theoretical data and sample data applied to cumulative theory. It can be seen from Table 44 and from Figures 37, 38, and 39 that data distributions fit rather nicely to the mathematical learning models. An exception is seen in Figure 41. Ss made the highest proportion of errors on the third session K3 trial. A number of explanations may be in order, (1) the IPI p of .85 was established for paper and pencil instruction, the CAI terminal may have acted as an uncontrolled treatment effect; (2) sample was too small; (3) probability learning theory does not account for differences

P (n) = 1 - θ

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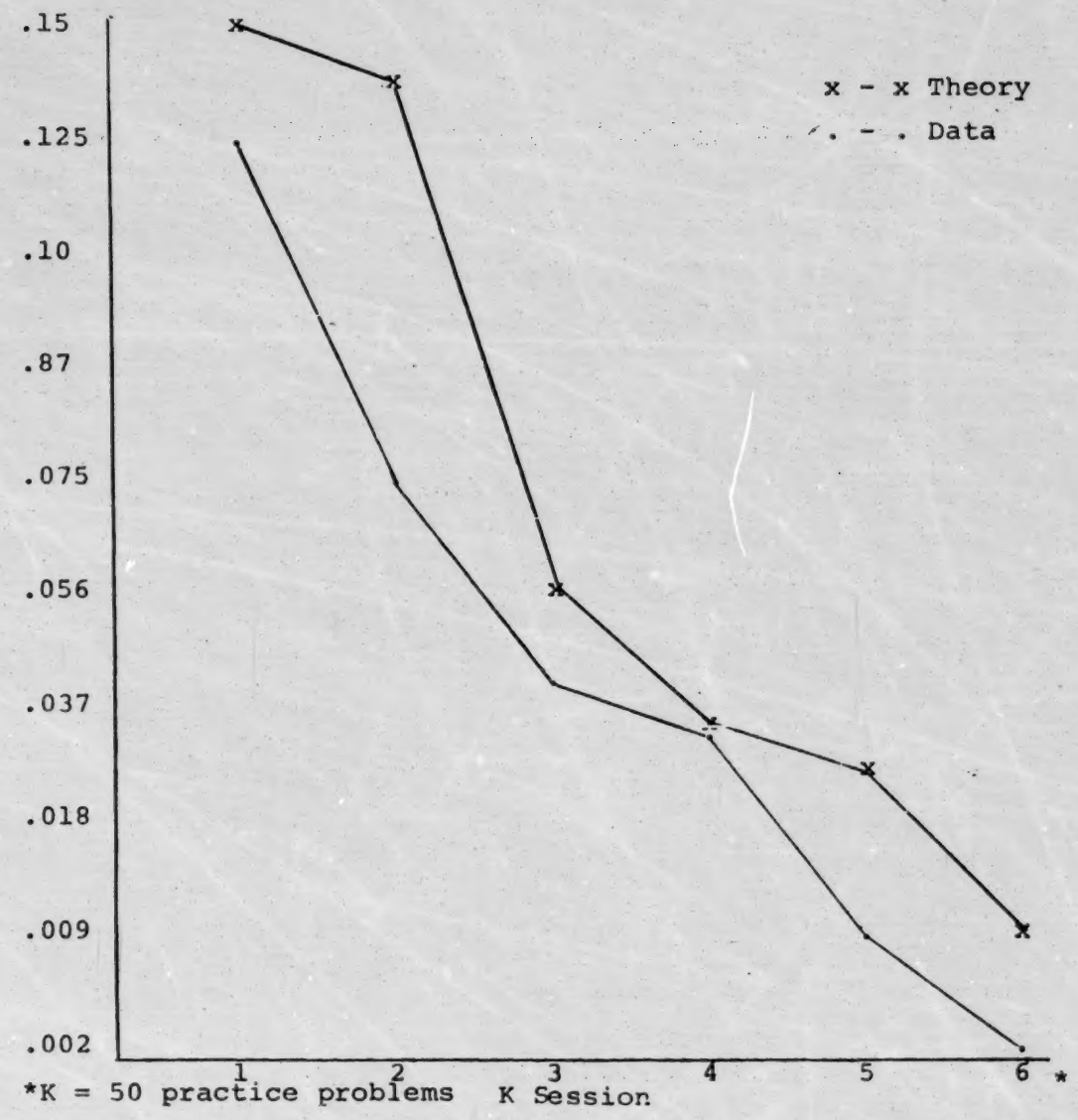

Figure 39. Proportion of items having last error on trial K

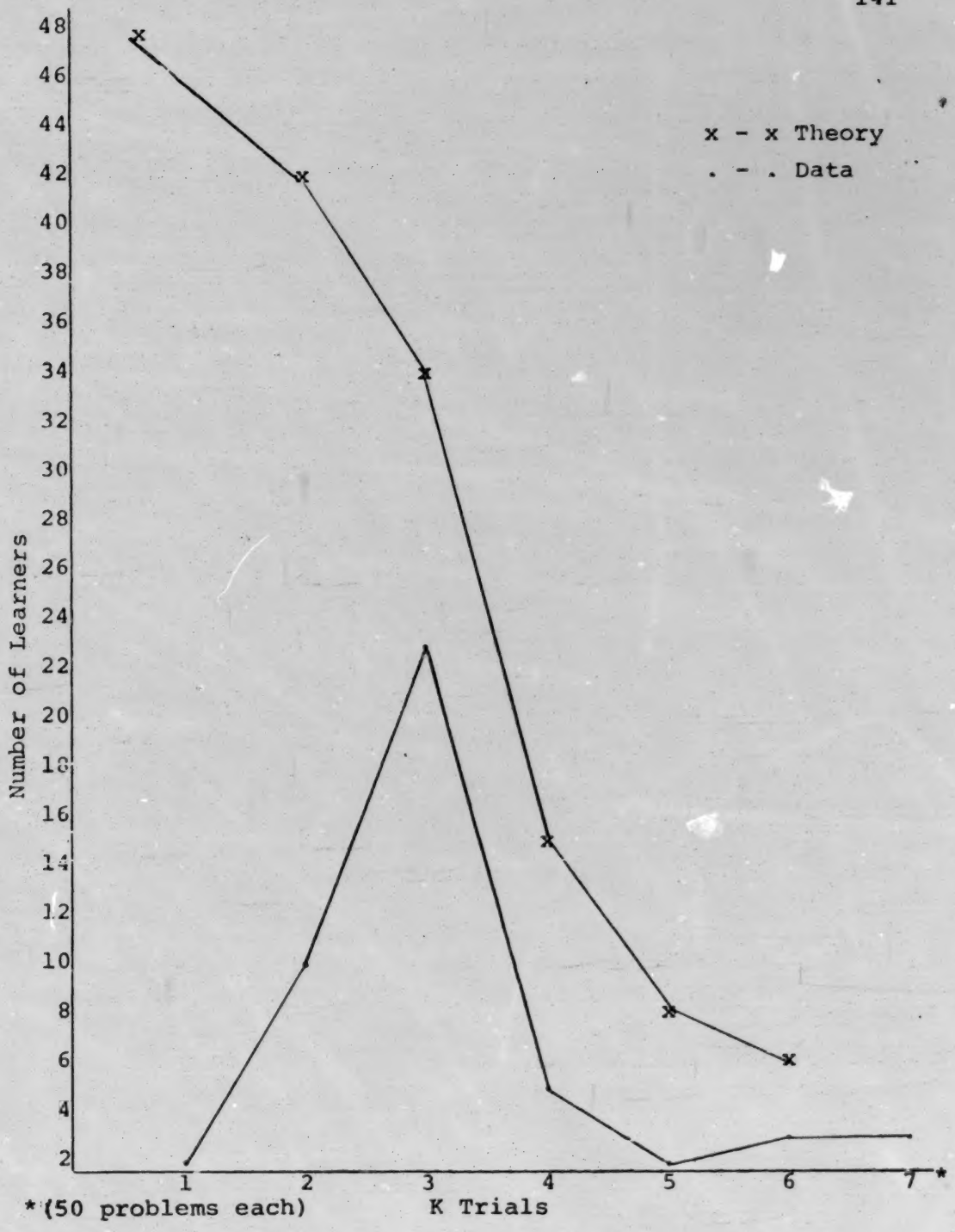

Figure 40. Number of learners with last error on trial K

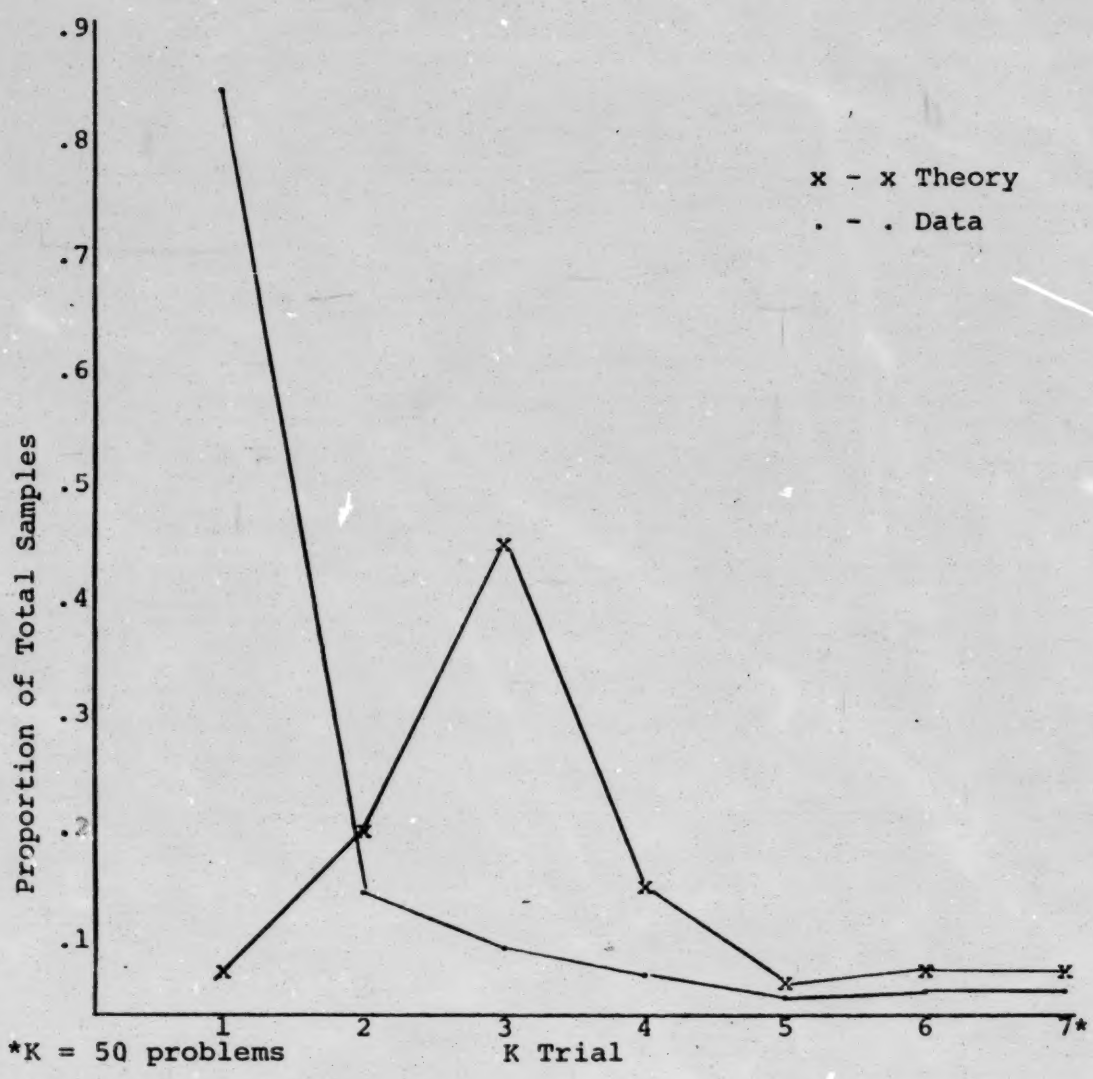

Figure 41. Proportion of learners with last error on trial K

Table 44. Cumulative learning curve data, proportion of errors at Trial K

Cumulative Proportion		Errors		K Trials
Data	Theory	Data	Theory	
1.00	.99+	598	597	6
.98	.99+	590	593	5
.95	.997	572	592	4
.88	.98	531	586	3
.76	.88	460	526	2
.49	.20	297	119	1

Derivation

k1 p = .20

k2 p = .85 (1-k1) + pk1 = .88

k3 p = .85 (1-k2) + pk2 = .98

k4 p = .85 (1-k3) + pk3 = .997

k5 p = .85 (1-k4) + pk4 = .998

k6 p = .85 (1-k5) + pk5 + .999

Table 45. Cumulative proportion of within group Ss vs maximum mean time at first errorless trial

Mean Maxi Time	Cum. n	Cum. Pro. of n	Mean Maxi Time	Cum. n	Cum. Pro. of n
Group I			Group III		
<20	1	.06	<40	2	.11
<40	3	.20	<60	4	.22
<60	8	.53	<80	6	.33
<80	9	.6	<100	14	.77
<100	10	.67	<140	15	.87
<120	12	.80	<200	17	.93
<140	14	.93	<220	18	1.00
<150	15	1.00			
Group II			Theory		
<40	1	.05	<40		.10
<60	5	.29	<60		.29
<80	7	.33	<80		.34
<100	9	.52	<100		.56
<120	11	.65	<140		.72
<160	14	.82	<160		.76
<200	15	.88	<200		.80
<260	16	.94	<220		.82
<466	17	1.00	<240		.85
			<275		.999

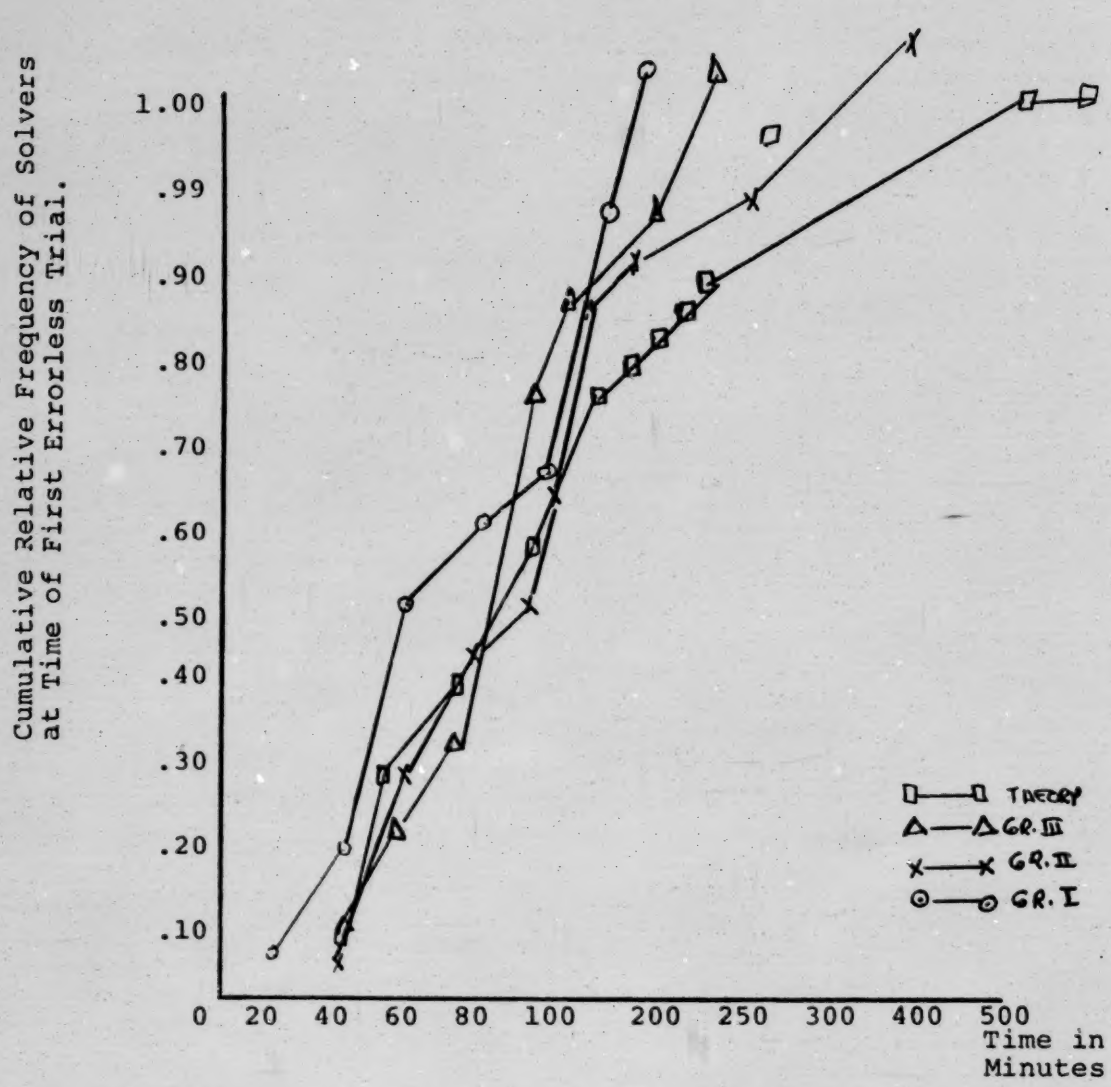

Figure 42. Cumulative proportion of learners and maximum time in minutes for K session on which last error was made

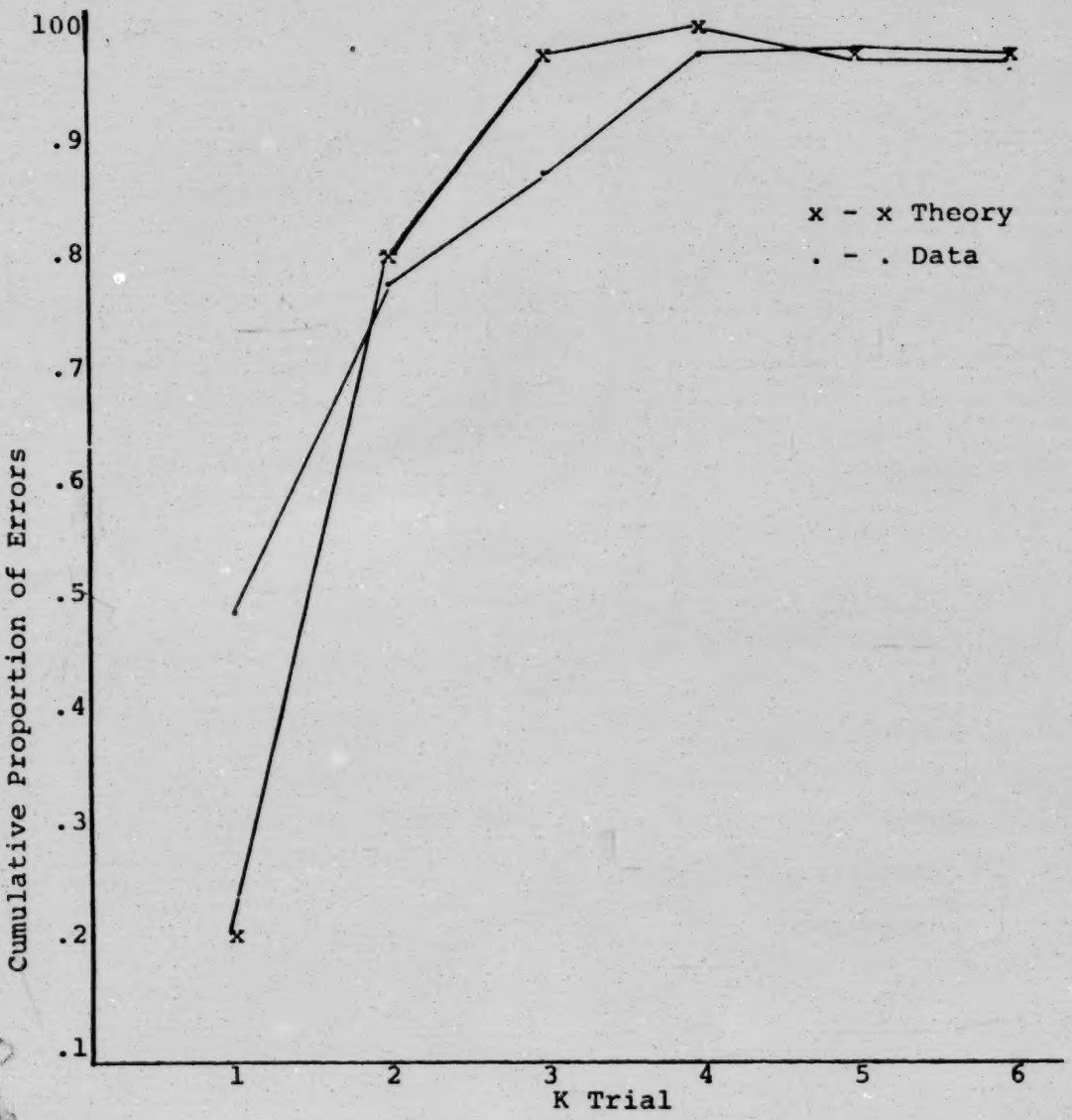

Figure 43. Cumulative proportion of total errors occurring on trial K

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in reinforcement schedules, in which case individual factors may have been operating to confound results.

Conclusions

In terms of scores on the immediate post test, the program utilizing knowledge of results as the reinforcement was significantly different from the programs utilizing various schedules of praise statements in addition to knowledge of results. Differences did exist between the groups on the other variables but were not significant.

In summary, the programs, in order of descending effectiveness, were 30% variable schedule, no reinforcement other than confirmation, and continuous reinforcement. These results are not contrary to those obtained by Lublin (1964) but they are more in agreement with findings by Krumboltz and Weisman (1962 b), who found no differences between schedules of reinforcement. It is suggested that significant differences might be obtained by (a) a longer program, (b) a different program, (c) a larger sample, (d) more control as treatment groups (e) a more sensitive criterion test such as delayed retention.

It is suggested that praise statements as social reinforcers may be necessary when learners are faced with a new situation, at that time they may need encouragement to establish confidence in their own ability to handle the situation. As confidence in the "ground rules" stabilizes, learners may then need a minimum of social approval and a

maximum of self approval, or knowledge of their own progress toward reaching goals. CAI is new to learners of all ages and levels of education, therefore provision must be insured that adequate orientation and social reinforcement be presented to all Ss until their task in the situation is focused on learning the subject matter rather than security and social approval. Adequate orientation may be required for individualization.

The findings in this study can be interpreted to substantiate Skinner's statement (1954) that reinforcement should be immediate and continuous until acquisition of new skills. If knowledge of results is indeed reinforcement, it was always immediate for all groups. This factor may have been coupled with the Zeigarnik effect, i.e. confirmation may have caused""closure" wherein the Ss dismissed the item from further consideration. As Lublin (1964) suggested in his study, the results here may indicate that Ss who "worked" for the 30 percent variable praise statements profited most on the program (as measured by the post test). Ss in group 11 may have had to remain more active and attentive to obtain their praise statements.

Implications and Recommendations

The delineation of major problems in the continuing education of adults is just beginning. Problems focusing on literacy skills, job retraining, updating of current knowledge, and those involving personal and social development can find innovative solutions only through the concerted

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efforts of behavioral scientists, professional educators, legislators, theorists and educational technologists. Sophisticated experimental designs similar to those utilized in the physical and biological sciences can today be applied to education due to the development of instructional media, such as the IBM1500 system, which has the capability of more precise control over the variables operating in the instructional situation. Experimental designs can assist in the investigation and clarification of some of the confusion related to effective instructional models, modes, strategies, programs, methods, materials and outcomes. The experimental method holds promise as the method for investigating the phenomena of learning.

This study investigated a number of variables that may aid in the design of CAI materials and programs. The following tentative model of the instruction situation permits the identification of suggested problems for further research:

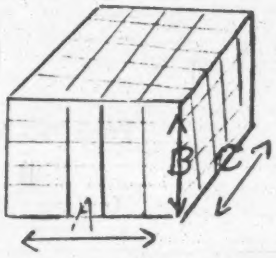

Figure 44. **Instructional model of input, process and output embedded in a learning situation.**

A = Input, personal characteristics, self assigned independent variables.

B = Process: Independent variables; theoretical constructs, techniques, media, modes, materials and programming strategies, and subject matter.

C = Output; outcomes; dependent variables; observable learner performances.

1. Self Concept.--It is possible that self concept may be an appropriate criterion for assessing the need of social reinforcers in learning materials and it may operate differentially with learners at various age and at various degrees of progress into the learning activity. It is recommended that further research be conducted that applies to this concept utilizing other self concept instruments. It is also recommended that research be conducted to design a more valid instrument.

2. Reinforcement Schedules.--To determine the effects of differential schedules in CAI, it is important that social reinforcers be separated from knowledge of results. It is possible that the effects of praise statements are being masked by the use of response confirmation. It is recommended that further research be conducted to replicate this study with the addition of two treatment groups (1) no confirmation and no praise statement and (2) no confirmation but praise statements 30% variable schedule.

3. CAI.--There should be some research design used to control the mode of instruction. IPI lends itself to this kind of study. The question of whether CAI is more effective than other modes cannot be answered until outcomes are compared with outcomes of other modes. One suggestion is to replicate this study using mode as treatment, with time, errors and achievement gains as dependent variables. Attitudes

toward CAI have not been researched. It is suggested that psychological constructs such as perception and motivation be investigated by utilizing them as dependent variables, subjecting them to treatments (CAI) and then testing for changes and outcomes on learning.

4. Individual Differences in Learning Styles and Self Pacing.--The design of this experiment should be replicated and expanded to control and test for differences in learning styles, verbal vs audio, logic strategies and ways of attacking problem solving. Studies should be conducted to test the effects of different grade levels of ability, educational attainment, age and need on specific learning materials. Here background and personal characteristics of learners would be independent variables, outcomes would be dependent variables. Characteristics of materials suitable to specific groups could then be identified.

Performance can be altered by the way in which praise is used during instruction. During early learning praise should follow all responses. After adjustment to the situation, low self concepts should receive consistent praise for low level skills but intermittent praise for higher skills, whereas high self concepts should receive intermittent praise for low skills and knowledge-of-results only for higher level skills.

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APPENDICES

Appendix A. Self Concept

BEST COPY AVAILABLE

Title: Tennessee Self Concept Scale

Author: William H. Fitts
Director of Research
Nashville Mental Health Center
Nashville, Tennessee

Date of Test: 1965

Publisher: Counselor Recordings and Tests
Box 6184 Acklen Station
Nashville, Tennessee 37212

General Description: The Scale consists of 100 self descriptive statements which the subject uses to describe himself. There are five possible responses ranging from completely false to completely true.

Groups for which the test is intended: The test can be administered to individuals or groups and can be used with subjects age 12 or higher and having at least a sixth grade reading level. It is applicable to the whole range of psychological adjustment from healthy, well adjusted people to psychiatric patients.

Purpose and Recommended Use: The scale was developed as an instrument to measure the self concept and the test manual suggests that results can be used for counseling clinical assessment and diagnosis, research in behavioral science, personnel selection, etc. The test preports to measure how an individual perceives himself.

The dimensions of the test include the physical self, moral-ethical self; personal self; family self; social self and self criticism.

Administration: The scale is self-administering and requires no instruction other than those found in the test manual. A separate answer sheet is necessary. The scale is usually completed in 10-20 minutes and the mean time for administration is 13 minutes.

Scoring: The scale can be scored either manually or with the use of the computer. The test manual suggests that computer scoring for 50 or more scales is available from the publisher. A scoring packet for hand scoring is also available.,

Crites reviews the Scale in the Journal of Counseling Psychology. Although he is critical of the test in several respects he indicates that the scale to a considerable extent fulfills the need of serving as a self concept measure. He says that it is simple for the subject, widely applicable, well standardized and multi-dimensional in it's description of the Self Concept.[1]

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1. Crites, J. O., Tennessee Self Concept Scale. (review) Journal of Counseling Psychology, 1965, pp. 12, 330-331.

Appendix B. Level D Fractions

The objectives of the IPI D level fractions are as follows:

1. Identifies objects using 1/6, 1/8, 2/3, 3/4.
2. Divides sets of objects into parts.
3. Adds any 2 fractions with the same denominator.
4. Adds 2 fractions, same denominator which equals a whole number.
5. Identifies an equivalent fraction for a given fraction, using pictures.

IPI MATHEMATIC PRE-TEST

LEVEL D, FRACTIONS (08)

SKILL 1

Total Points 7	100%
No. of Points	%
6	86
5	71
4	57
3	43
2	29
1	14

SKILL 2

Total Points 10	100%
No. of Points	%
9	90
8	80
7	70
6	60
5	50
4	40
3	30
2	20
1	10

SKILL 3

Total Points 10	100%
No. of Points	%
9	90
8	80
7	70
6	60
5	50
4	40
3	30
2	20
1	10

SKILL 4

Total Points 12	100%
No. of Points	%
11	92
10	83
9	75
8	67
7	58
6	50
5	42
4	33
3	25
2	17
1	8

SKILL 5

Total Points 5	100%
No. of Points	%
4	80
3	60
2	40
1	20

IPI MATHEMATICS POST-TEST

LEVEL D, FRACTIONS (08)

SKILL 1

Total Points 7	100%
No. of Points	%
6	86
5	71
4	57
3	43
2	29
1	14

SKILL 2

Total Points 10	100%
No. of Points	%
9	90
8	80
7	70
6	60
5	50
4	40
3	30
2	20
1	10

SKILL 3

Total Points 10	100%
No. of Points	%
9	90
8	80
7	70
6	60
5	50
4	40
3	30
2	20
1	10

SKILL 4

Total Points 12	100%
No. of Points	%
11	92
10	83
9	75
8	67
7	58
6	50
5	42
4	33
3	25
2	17
1	8

SKILL 5

Total Points 5	100%
No. of Points	%
4	80
3	60
2	40
1	20

Appendix C. Assignment of Learners to Groups

Number	Group
L 529	3
L 555	2
L 8	1
L 13	2
L 506	3
L 46	1
L 7	3
L 30	2
L 560	1
L 14	1
L 44	1
L 18	3
L 548	1
L 564	1
L 29	3
L 530	1
L 11	2
L 20	1
L 45	1
L 28	2
L 15	2
L 549	2
L 27	2
L 43	2
L 571	1
L 510	2
L 566	2
L 12	2
L 26	1
L 568	3
L 33	1
L 511	1

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Assignment of Learners to Groups (Continued)

Number	Group
L 556	2
L 512	1
L 25	3
L 526	1
L 24	1
L 23	2
L 565	2
L 558	3
L 570	2
L 5	2
L 34	2
L 4	1
L 563	3
L 523	2
L 41	3
L 35	1
L 521	3
L 19	2
L 524	3
L 36	2
L 553	3
L 562	3
L 37	1
L 16	3
L 569	3
L 525	1
L 513	2
L 516	3
L 518	1
L 557	2
L 40	2
L 3	3
L 2	2
L 39	1

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Assignment of Learners to Groups (Continued)

Number	Group
L 567	1
L 561	2
L 538	2
L 21	3
L 528	1

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Appendix D. Tennessee Self Concept Documentation

Course Name - 61000-001

Programmer - Ron McCann

Macron Used - CWG3 (generate over and over for student response)

Functions Used - Move Buffer ⟶ Buffer

Audio Tape Used - One for Self Concept Test - VISDE-Bell-61000 and hold momentarily

Buffers - B4 - Used to Record Response

B5 - Accumulates and Stores Responses

Switches - 1, 2, 3, 4, 5 For Internal Branching (According to which box student selects)

Counters - C19 - Used as an Index in a Loop

Proctor Actions - Press Space Bar either once or twice

Print Out - Student's 100 Responses, Students Name

Buffer - B3 - A dt temporary hold for boxes on screen when student is actually taking the last practice exercise at the beginning of this testing.

Tennessee Self Concept Documentation (Continued)

Course Description:

61000-001 begins with an audio description of the test. The light boxes and the light pen are then explained. Several responses are requested of the student to test his understanding of the different light boxes. A sample statement is given and the student responds followed by an audio playback of the student's response. The test questions or statements are then played with a "sleeper" statement inserted after statement #19 to determine if the student is paying attention or not. This statement, "I live in the United States", should be answered, "totally true", otherwise the proctor is called. After statement #39 the student is allowed a short break. There are 100 statements that are recorded (the response to the sleeper statement is not recorded.

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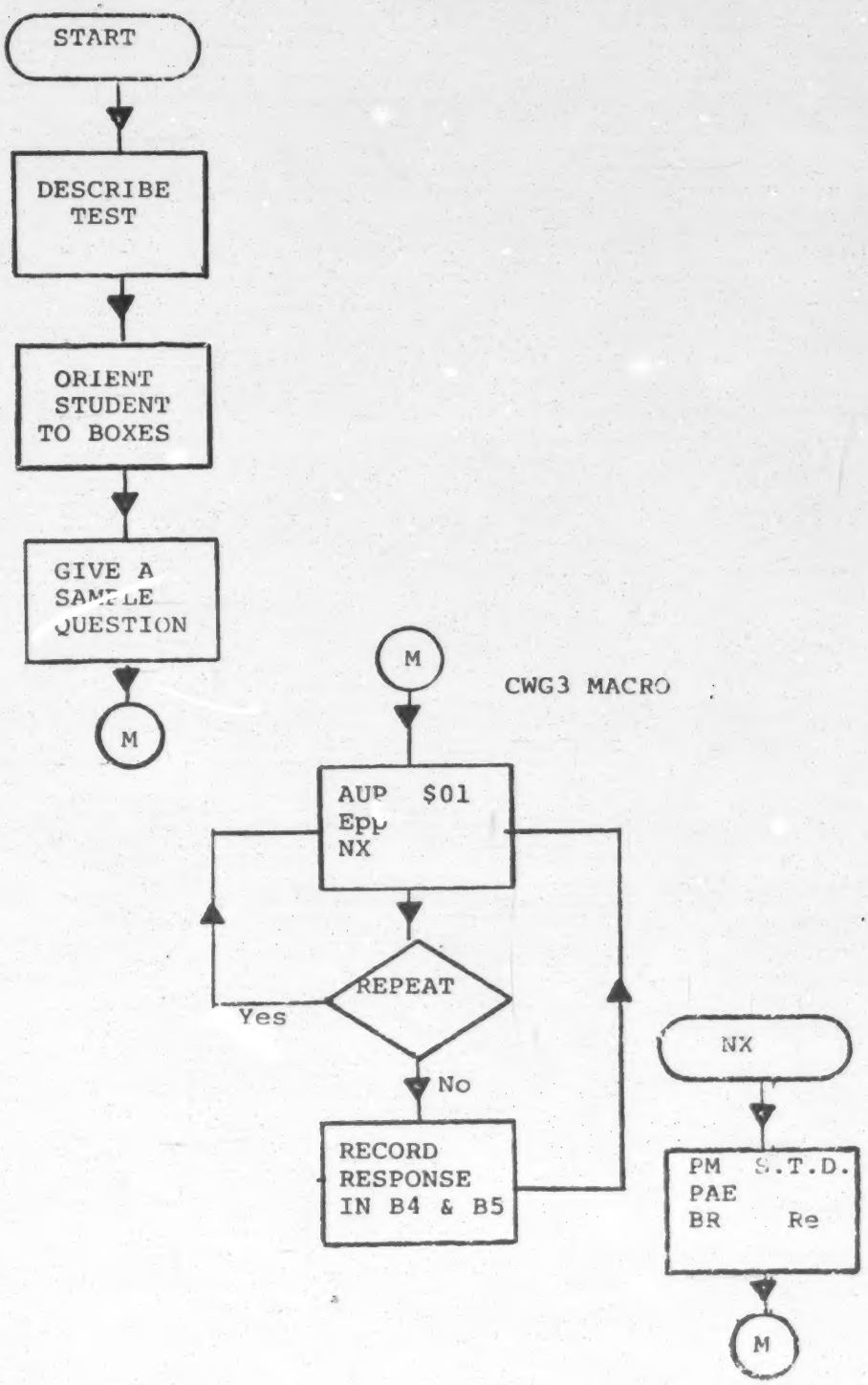
PROGRAMMING FLOWCHART



SELF CONCEPT ANALYSIS REPORT

BREWER L147 03/20/70

TOTAL P	263
NET CONFLICT	95
TOTAL CONFLICT	95
PERSONAL	47
SOCIAL	51
ETHICAL	52
FAMILY	57
PHYSICAL	56
SELF CRITICISM	27

SELF CONCEPT DATA PRINTOUT

SELF CONCEPT ANSWERS FOR:

W. TAYLOR

1557

4531113131554551545451113111533551535411134114114513215551113431125555435551113351124552215554555555

Take this to the proctor

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Appendix E. Data Columns Needed

A. Student Number
B. Program
C. Group
D. Self Concept
E. Pre-test
F. Post Test
G. Gains
H. Needed for Mastery
I. % Achievement
J. Total Trials
K. % Gained per Trial
L. Trials per gain
M. Total Time
N. Time per Trial (minutes, tenths)
O. Trials per Minute
P. Time per Achievement
Q. Total Errors
R. Error rate per trial
S. Errors for 1st 50 Trials
T. Errors for 2nd 50 Trials
U. Errors for 3rd 50 Trials
V. Errors for 4th 50 Trials
W. Errors for 5th 50 Trials
X. Errors for 6th 50 Trials
Y. Time 1st 50 Trials
Z. Time 2nd 50 Trials
Za. Time 3rd 50 Trials
Zb. Time 4th 50 Trials
Zc. Time 5th 50 Trials
Zd. Time 6th 50 Trials

1. Total correlational matrix (C to R)
2. Means and Sd for D-Zd
3. Within column C for each of (1), (2), and (3) means and Sd for D through Zd
4. Median for Column D
5. For Column C the number above the Median for each of (1), (2), and (3) and the number below the Median for each
6. For Column C, A correlational matrix of all columns within group (1), (2), and (3)
7. Within groups a regression slope for errors and trials; errors and achievement, errors and time
8. For Column D a regression slopes for above average, below average on pre-test, post-test, achievement rate
   A variance ration (F) and p
9. Reinforced Achievement and Self Concept Level

Achievement	Self Concept Level	CR of Difference	
	Above Average	Below Average	p
Knowledge of Results (Mean Score)	-	-	
30% Schedule (Mean Score)	-	-	
100% Schedule (Mean Score)	-	-	

10. Regression slope for (p), (Q), (R) and S
    " " " " " " " T
    " " " " " " " U
    " " " " " " " V
    " " " " " " " W
    " " " " " " " X

Appendix F. Data Summary

	GAINS			ACHIEVEMENT			TOTAL TRIALS			TOTAL TIME			TOTAL ERRORS			LEARNING RATE		
	GROUP I	GROUP II	GROUP III	GROUP I	GROUP II	GROUP III	GROUP I	GROUP II	GROUP III	GROUP I	GROUP II	GROUP III	GROUP I	GROUP II	GROUP III	GR. I	GR. II	GR.III
COVARIANTS																		
MEANS SC	276.75	271.936	278.4	276.8	271.9	278.4	276.8	271.9	278.4	276.8	271.9	278.4	276.7	271.9	278.4			
ADJ. MEANS	315.46	310.64	317.14															
Intercept	-60.21	65.48	-12.34	207.69	35.83	252.36	-363.50	-340.73	-420.4	204.46	-68.95	-449.18	-42.175	-27.04	-172.50			
Slope-b1	.2751	-.1425	.1142	-.4486	.1627	-.636	1.754	1.747	1.981	-.462	.6126	1.954	.186	.142	.664			
RESIDUAL MS	137.87	457.67	170.78	377.63	382.82	448.34	1688.5	4634.7	4200.5	1564.5	3620.5	4041.0	52.97	70.58	233.35			
R^2	.073	.009	.028	.071	.014	.252	.207	.118	.259	.019	.021	.259	.086	.055	.414			
OVERALL																		
INTERCEPT	14.962				182.80			-359.35			-185.71			-101.05				
SLOPE-b 1	.0196				-.3741			1.772			.996			.407				
RESIDUAL	261.39				404.17			3288.8			3130.64	125.86						
R_2		.0003			.073			.178			.067	.230						
ANAL. VAR. df		SS	MS		SS	MS		SS	MS		SS	MS		SS	MS		SS	MS
Treat. 2		1020.399	510.20		536.156	268.08		1354.17	677.08		389994	1949.97		86.79	43.39		.1279	.0639
Pool err. 45		11007.451	744.61		19521.422	433.81		182811.50	4062.5		150496.79	3344.37		7437.19	165.27		2.7689	.0615
STATISTICS																		
GEN. MEAN		20.375			79.656			129.167			88.858			11.146			.2901	
C.V. (%)		76.76			26.15			49.35			65.08			115.34			85.5055	
LSD (.05)		9.289			12.371			37.858			34.349			7.636			.1473	
TREATMENTS																		
MEANS	15.9375	26.7312	18.456	83.5313	80.0625	75.357	121.875	134.375	131.25	76.462	97.631	92.481	9.3125	11.625	12.50	.2667	.3617	.2418
VARIANCE	138.856	431.025	163.95	379.516	362.369	559.58	1989.58	4906.25	5291.67	1489.00	3450.517	5093.60	54.096	69.717	372.00			
	*Significant at the .05 level																	

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